SOIL SURVEY OF

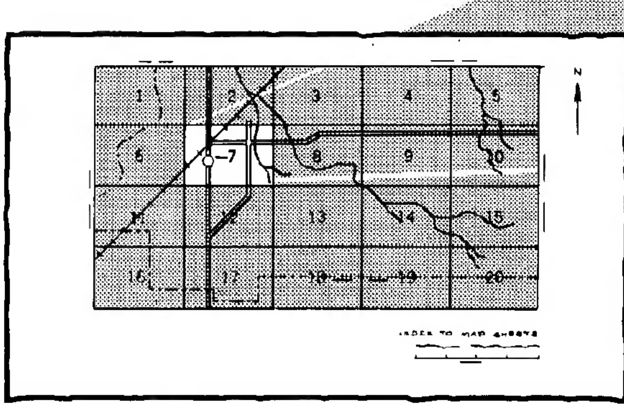
KNOX COUNTY, TEXAS

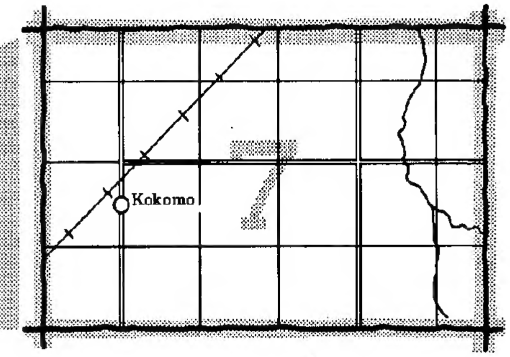
United States Department of Agriculture
Soil Conservation Service

in cooperation with
Texas Agricultural Experiment Station

HOW TO USE

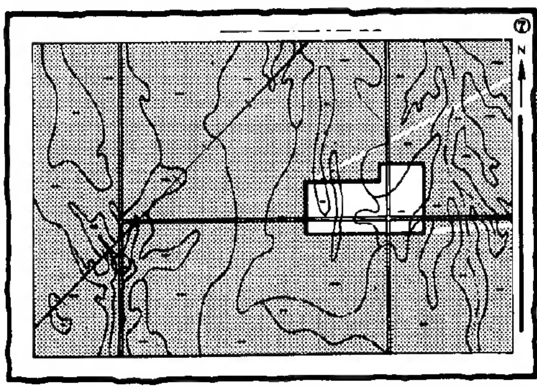
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

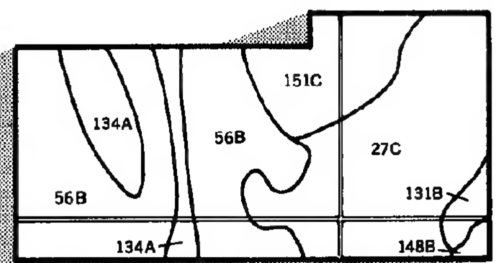




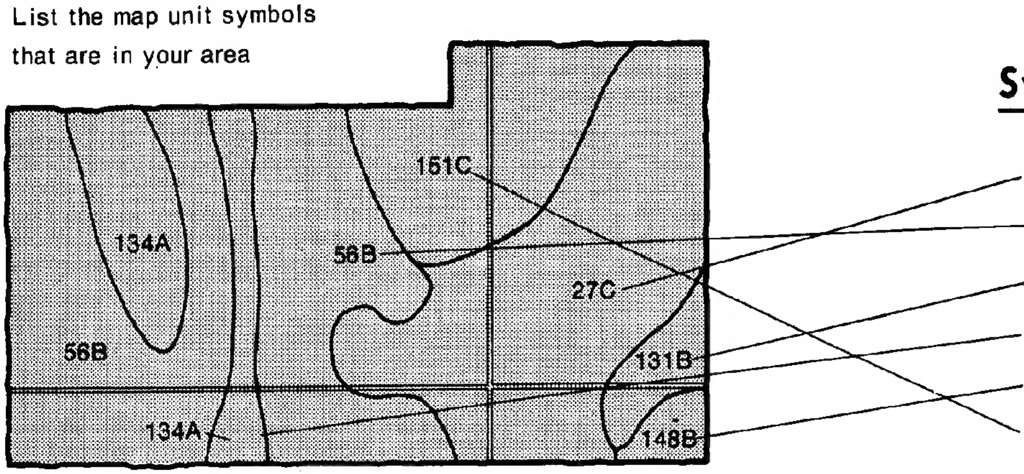
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.





4. List the map unit symbols that are in your area

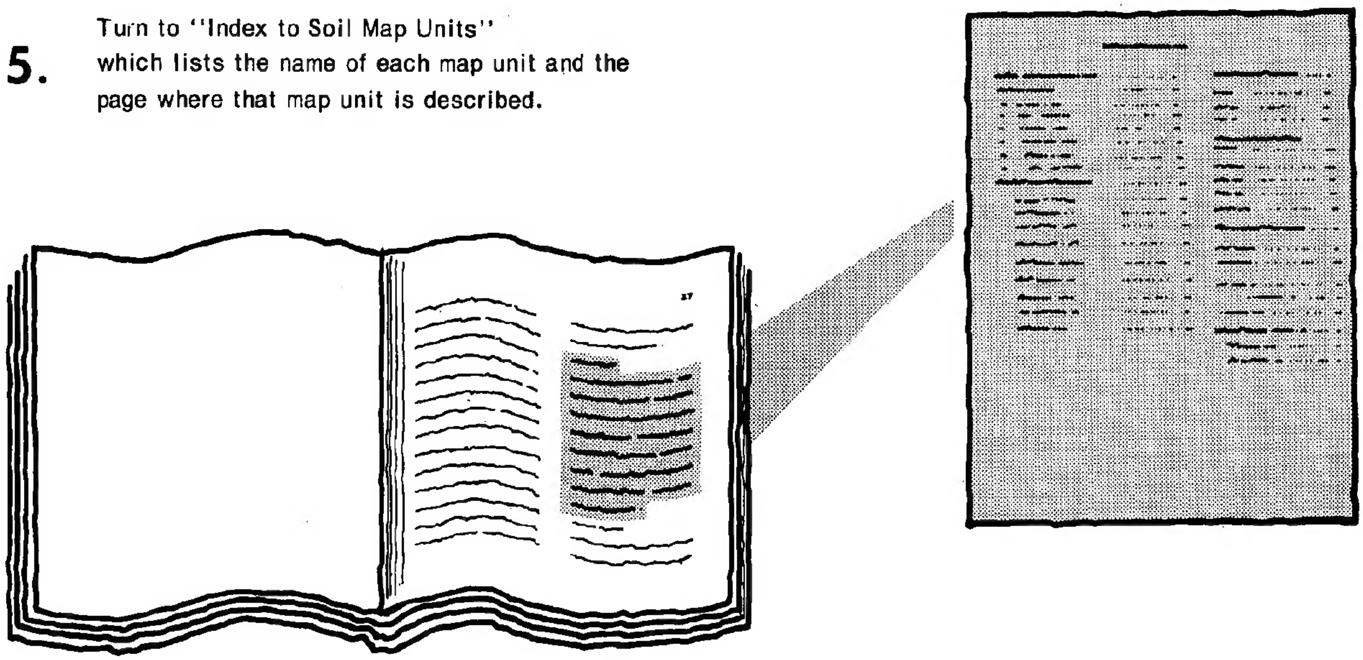


Symbols

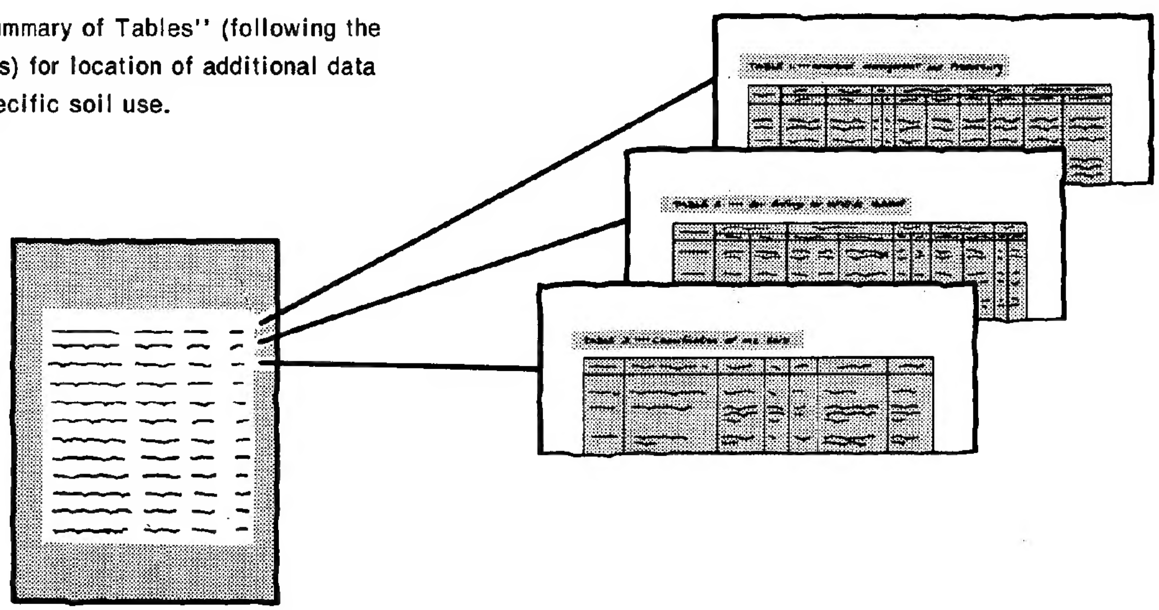
27C
56B
131B
134A
148B
151C

THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1970-74. Soil names and descriptions were approved in 1975. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1975. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Wichita-Brazos Soil and Water Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

Cover: Wheat on irrigated Rotan clay loam, 0 to 1 percent slopes.

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Issued January 1979

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Foreword

This soil survey contains much information useful in land-planning program in Knox County, Texas. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

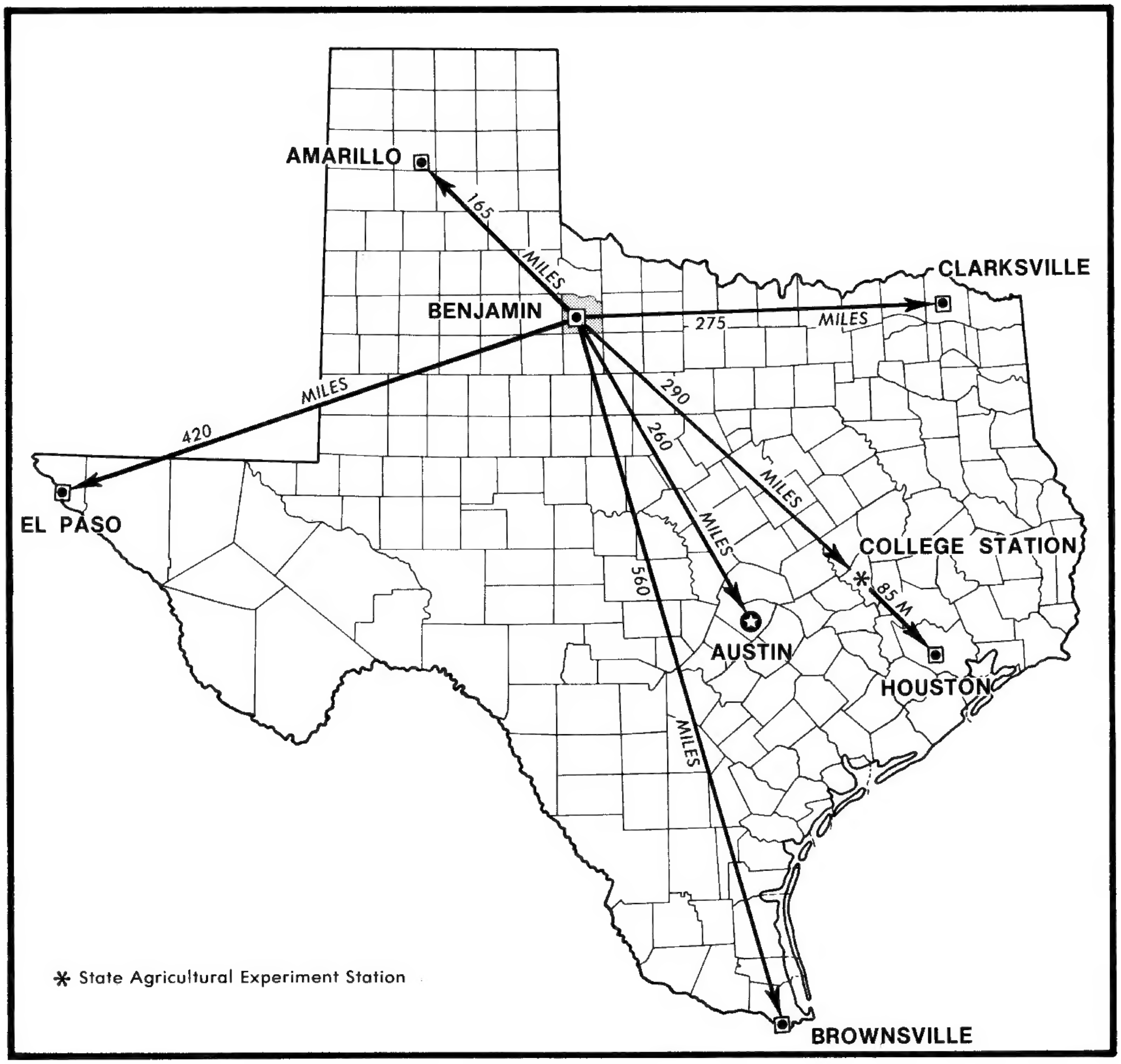
This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.

George C. Marks
State Conservationist
Soil Conservation Service



Location of Knox County in Texas.

SOIL SURVEY OF KNOX COUNTY, TEXAS

By Colletus A. Rogers and William M. Risinger,
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United States Department of Agriculture, Soil Conservation Service,
in cooperation with Texas Agricultural Experiment Station

KNOX COUNTY is in the northwestern part of Texas (see facing page). Benjamin, the county seat, has a population of 308. Other towns in the county are Munday, with a population of 1,726; Knox City, with a population of 1,536; and Goree, with a population of 538. The county has a total area of 551,040 acres, or 861 square miles.

Knox County is in the Rolling Red Plains section of the Southern Great Plains. It is drained by the North Wichita, South Wichita, and Brazos Rivers. Elevation ranges from 1,300 feet along the Brazos River to 1,700 feet in the northwestern section of the county.

About 58 percent of the county is range, and about 40 percent is cropland. The remaining 2 percent is water and urban land. About 30 percent of the cropland is irrigated. Less than 1 percent of the county is irrigated pasture. Raising beef cattle is the principal ranching enterprise. Cotton, grain sorghum, and wheat are the main cultivated crops.

General nature of the county

This section discusses briefly the history, natural resources, and climate of the county.

History

Knox County was created from Bexar and Young Territories in 1858, recreated in 1876, and organized in 1886. The county was named for General Henry Knox, U.S. secretary of war.

The population of Knox County increased from 77 in 1880 to a high of 11,368 in 1930. By 1970 the population had decreased to 5,972.

Climate

The official weather station for Knox County is in Munday. Table 1 gives data on temperature and precipitation for the county. Data for this section were obtained from the National Oceanic and Atmospheric Administration, National Weather Service.

Knox County has a warm-temperate subtropical climate with dry winters and hot, humid summers. Tropical Maritime airmasses play a dominant role in determining the climate of the area from April through October, while those air masses of polar origin largely control the climate from November through March. There is a wide range in annual extremes of temperature characteristic of a continental environment. The mean total annual precipitation at Munday is 24.89 inches, approximately three-fourths of which falls during the warm season, April through October. Rainfall, which is mostly in the form of thundershowers, may vary considerably from month to month and from year to year.

The prevailing winds in Knox County are southerly to southeasterly throughout the year, except in January and February when northerly winds are the most frequent. The survey area receives approximately 64 percent of the total possible sunshine in winter, 68 percent in spring, 77 percent in summer, and 71 percent in fall. Mean relative humidity at noon, Central Standard Time, is estimated at 53 percent in January, 46 percent in April, 44 percent in July, and 48 percent in October. Thunderstorms occur on 44 days in an average year.

Surges of polar Canadian airmasses are common in winter, but cold spells are brief and are not severe. Cold fronts often are accompanied by strong, gusty winds and a sudden decrease in temperature; however, the cloudiness associated with the frontal passages dissipates quickly, and sunshine and southerly winds bring rapidly rising temperatures.

Winter is a relatively dry period. Snow may fall once or twice a month, but accumulations are rare. Strong winds often accompany snowfalls, and considerable drifting occurs.

Spring is a pleasant season in Knox County. Rapid changes in weather often occur in March. Showers increase in April, and thunderstorm activity peaks in May. Occasionally, thunderstorms late in spring and early in summer are accompanied by destructive winds and hail. As spring progresses, cold fronts become weaker, and temperature changes are more moderate. March and April are the windiest months.

Daytime temperatures are hot in summer, and there are only a few days when the temperature does not reach or exceed 90 degrees F. Days with temperatures above 100 degrees F. are not uncommon. Evaporative type home air conditioners operate effectively more than 90 percent of the time in July and August.

Fall is the best season in Knox County for most outdoor activities, except swimming. Temperatures are moderate, winds are light, and fair weather persists.

The mean length of the warm season, or freeze-free period, in Knox County is 217 days. The mean date of the last occurrence of 32 degrees F. or below in spring is April 3, and the first occurrence of 32 degrees F. or below in fall is November 6.

Natural resources

Soil is the most important natural resource in the county. Livestock and crops are marketable products.

Water is also an important natural resource and is used for irrigation in the southern part of the county. In most areas of the county, water is adequate for domestic use. Stock tanks are needed for watering livestock in some parts of the county.

Oil is a natural resource and is produced mostly in the southern part of the county.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken for laboratory measurements and engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from State and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information is then organized and published so that it is readily available to different groups of users, among them farmers, managers of rangeland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the back of this survey shows, in color, the seven map units in Knox County. Each unit has a unique natural landscape with a distinctive pattern of soils, relief, and drainage features. It consists of two or more major soils and some minor soils, and it is named for the major soils. The soils in one unit may occur in another, but in a different pattern.

The map provides a broad perspective of the soils and the landscape in Knox County and a basis for comparing the potentials of the seven units of the county for general kinds of land use. From the map, large areas that are generally suitable for certain kinds of farming or other land uses can be identified. Also, large areas that have soil properties distinctly unfavorable for certain land uses can be identified.

Because of the scale used, the smallest unique soil unit that can be mapped is about 160 acres in size. The map does not show the kind of soil at a particular place. Thus, it is not suitable for planning the management of a farm or field or for selecting the exact location of a road, building, or similar structure.

In this section, each map unit is described and its limitations and potentials for selected land uses are discussed.

Soil descriptions and potentials

1. Knoco-Vernon

Very shallow to moderately deep, calcareous, clayey soils on uplands

The soils in this map unit are gently sloping to sloping. Slopes range from 1 to about 8 percent.

This map unit makes up about 30 percent of the survey area. It is about 34 percent Knoco soils, 19 percent Vernon soils, and 47 percent minor soils and Badland.

Knoco soils have a surface layer of red, calcareous, moderately alkaline clay about 8 inches thick. The underlying material is red, moderately alkaline clayey shale.

Vernon soils have a surface layer of reddish brown, calcareous, moderately alkaline clay about 8 inches thick. Between depths of 8 and 22 inches is reddish brown, calcareous, moderately alkaline clay that contains a few fine calcium carbonate concretions. Between depths of 22 and 32 inches is reddish brown, calcareous, moderately alkaline clay. The underlying material, to a depth of 60 inches, is weak red, calcareous, moderately alkaline clayey shale.

Among the minor soils in this map unit are Clairemont, Cobb, Cosh, Owens, and Mangum soils. Badland is also included. It is exposed redbed clayey shale that is devoid of vegetation.

This map unit is used for range. The potential is medium for native range plants. Limited rainfall, low available water capacity, and restricted rooting depth limit the amount of forage grown during favorable years. The potential is low for farming because of erosion, complex slopes, and soil depth. The potential is low for urban and recreation uses because of complex slopes, soil depth, and shrinking and swelling of the clayey surface layer.

2. Miles-Rotan

Deep, noncalcareous, loamy soils on uplands

The soils in this map unit are nearly level. Slopes are mostly less than 1 percent.

This map unit makes up about 26 percent of the survey area. It is about 48 percent Miles soils, 16 percent Rotan soils, and 36 percent minor soils (fig. 1).

Miles soils have a surface layer of reddish brown, neutral fine sandy loam about 10 inches thick. Between depths of 10 and 27 inches is reddish brown, neutral sandy clay loam and between depths of 27 and 35 inches is red, neutral sandy clay loam. Red, mildly alkaline sandy clay loam is between depths of 35 and 54 inches. The underlying material, to a depth of 70 inches, is red, calcareous, moderately alkaline sandy clay loam.

Rotan soils have a surface layer of dark grayish brown, mildly alkaline clay loam about 10 inches thick. Between depths of 10 and 18 inches is dark grayish brown, mildly alkaline clay loam; between depths of 8 and 24 inches is dark brown, moderately alkaline clay; and between depths of 24 and 36 inches is dark brown, calcareous, moderately alkaline clay. Between depths of 36 and 62 inches is brown, calcareous, moderately alkaline clay that contains about 40 percent by volume, soft bodies and concretions of calcium carbonate. The underlying material, to a depth of 70 inches, is yellowish red, calcareous, moderately alkaline clay that contains about 10 percent by volume, soft bodies and concretions of calcium carbonate.

Among the minor soils in this map unit are Altus, Clairemont, Enterprise, Hardeman, Sagerton, and Winters soils.

This map unit is used mainly for cultivated crops. The potential is high for row crops and small grain. A few areas are used for range. The potential is high for native range plants. Yields of forage are good during favorable years. The potential is high for most urban and recreation uses. The clay loam surface layer, shrinking and swelling, and slow percolation of the Rotan soils are limitations for some uses.

3. Tillman-Hollister-Wichita

Deep, noncalcareous and calcareous, loamy soils on uplands

The soils in this map unit are nearly level to gently sloping. Slopes are 0 to about 5 percent.

This map unit makes up about 23 percent of the survey area. It is about 24 percent Tillman soils, 15 percent Hollister soils, 15 percent Wichita soils, and 46 percent minor soils (fig. 2).

Tillman soils have a surface layer of reddish brown, mildly alkaline clay loam about 7 inches thick. Between depths of 7 and 16 inches is reddish brown, moderately alkaline clay. Between depths of 16 and 56 inches is reddish brown, calcareous, moderately alkaline clay that contains soft bodies of calcium carbonate. The underlying material, to a depth of 80 inches, is yellowish red, calcareous, moderately alkaline clay that contains a few soft bodies, films, and threads of calcium carbonate.

Hollister soils have a surface layer of dark brown, moderately alkaline clay loam about 6 inches thick. Between depths of 6 and 37 inches is dark brown, calcareous, moderately alkaline clay. Between depths of 37 and 62 inches is dark brown, calcareous, moderately alkaline clay that contains a few very fine calcium carbonate concretions and between depths of 62 and 80 inches is red, calcareous, moderately alkaline clay that contains about 10 percent, by volume, soft bodies and concretions of calcium carbonate.

Wichita soils have a surface layer of reddish brown, mildly alkaline clay loam about 8 inches thick. Between depths of 8 and 17 inches is reddish brown, mildly alkaline clay loam and between depths of 17 and 38 inches is reddish brown, calcareous moderately alkaline clay. Between depths of 38 and 52 inches is red, calcareous, moderately alkaline clay that contains a few calcium carbonate concretions. The underlying material, to a depth of 70 inches, is red, calcareous, moderately alkaline clay that contains 10 percent, by volume, soft bodies and concretions of calcium carbonate.

Among the minor soils in this map unit are Aspermont, Clairemont, Cobb, Cosh, Mangum, Tobosa, Sagerton, and Vernon soils.

This map unit is used for range and cropland. The potential is high for row crops and small grain. The potential is high for native range plants. Yields of forage are good during favorable years. The potential is medium for most urban and recreation uses. The clay loam surface layer, shrinking and swelling, and slow percolation are the most limiting features.

4. Cottonwood-Knoco

Very shallow, calcareous, clayey and loamy soils on uplands

The soils in this map unit are gently sloping to moderately steep. Slopes are 1 to about 20 percent.

This map unit makes up about 7 percent of the survey area. It is about 45 percent Cottonwood soils, 25 percent Knoco soils, and 30 percent minor soils (fig. 3).

Cottonwood soils have a surface layer of reddish brown, calcareous, moderately alkaline clay loam about 8 inches thick. The underlying layer is white, weakly cemented gypsum.

Knoco soils have a surface layer of red, calcareous, moderately alkaline clay about 8 inches thick. The underlying material is red, calcareous, moderately alkaline clayey shale.

Among the minor soils in this map unit are Mangum, Owens, Tillman, Vernon, and Wichita soils. This map unit is used for range. The potential is low for native range plants. The potential is low for farming because of the very shallow root zone and complex slopes. Limited rainfall, low available water capacity, and restricted rooting depth limit the amount of forage grown during favorable years. The potential is low for urban and recreation uses because of complex slopes, the clay loam or clay surface layer, shrinking and swelling, and soil depth.

5. Hardeman-Enterprise-Lincoln

Deep, calcareous, loamy and sandy soils on uplands and bottom lands

The soils in this map unit are nearly level to strongly sloping. Slopes are 0 to about 12 percent.

This map unit makes up about 7 percent of the survey area. It is about 31 percent Hardeman soils, about 23 percent Enterprise soils, about 16 percent Lincoln soils, and about 30 percent minor soils (fig. 4).

Hardeman soils have a surface layer of reddish brown, calcareous, moderately alkaline fine sandy loam about 13 inches thick. Between depths of 13 and 42 inches is yellowish red, calcareous, moderately alkaline fine sandy loam. The underlying material, to a depth of 60 inches is reddish yellow, calcareous, moderately alkaline fine sandy loam. It contains a few films and threads of calcium carbonate.

Enterprise soils have a surface layer of reddish brown, mildly alkaline very fine sandy loam about 16 inches thick. The subsoil is yellowish red, calcareous, moderately alkaline very fine sandy loam about 25 inches thick. It contains a few films and threads of calcium carbonate. The underlying material, to a depth of 72 inches, is reddish brown, calcareous, moderately alkaline very fine sandy loam that contains a few films and threads of calcium carbonate.

Lincoln soils have a surface layer of yellowish red, calcareous, moderately alkaline fine sand about 8 inches thick. Between depths of 8 and 50 inches is reddish yellow, calcareous, moderately alkaline fine sand. The underlying material, to a depth of 70 inches, is yellowish red, calcareous, moderately alkaline loamy fine sand.

Among the minor soils in this map unit are Clairemont, Mangum, and Yahola soils. This map unit is used mainly for range. The potential is high for native range plants. Yields of forage are good during favorable years. The nearly level and gently sloping areas of Enterprise and Hardeman soils are mostly cultivated, and potential is high for row crops and small grain. The potential is low for urban uses in most of this map unit because of flooding and complex slopes. The potential is high for urban uses in some nearly level to gently sloping areas of Hardeman soils. The potential is high for recreation use. The fine sand surface layer of the Lincoln soils limits some uses.

6. Clairemont-Mangum

Deep, calcareous, clayey and loamy soils on bottom lands

The soils in this map unit are nearly level. Slopes are mostly less than 1 percent.

This map unit makes up about 4 percent of the survey area. It is about 42 percent Clairemont soils, about 40 percent Mangum soils, and about 18 percent minor soils.

Clairemont soils have a surface layer of red, calcareous, moderately alkaline silt loam about 12 inches thick. Between depths of 12 and 36 inches is red, calcareous, moderately alkaline silty clay loam; between depths of 36 and 42 inches is reddish brown, calcareous, moderately alkaline silty clay loam; and between depths of 42 and 56 inches is light red, calcareous, moderately alkaline silty clay loam. The underlying material, to a depth of 80 inches, is reddish brown, calcareous, moderately alkaline silty clay loam.

Mangum soils have a surface layer of reddish brown, calcareous, moderately alkaline clay about 10 inches thick. Between depths of 10 and 42 inches is reddish brown, calcareous, moderately alkaline clay that contains a few thin strata of silt loam in the lower 16 inches. The underlying material, to a depth of 60 inches, is reddish brown, calcareous, moderately alkaline clay that contains a few calcium carbonate concretions.

This map unit is used for range. The potential is high for native range plants. Yields of forage are good during favorable years. The potential is low for cultivation and

urban use because of flooding. The potential is medium for recreational uses, also because of flooding. Dust limits uses of the Clairemont soils, and the clay surface layer of the Mangum soils limits some recreation uses.

7. Miles-Springer

Deep, noncalcareous, sandy soils on uplands

The soils in this map unit are nearly level to gently undulating. Slopes are 0 to about 5 percent.

This map unit makes up about 3 percent of the survey area. It is about 63 percent Miles soils, about 25 percent Springer soils, and about 12 percent minor soils.

Miles soils have a surface layer of reddish brown, mildly alkaline loamy fine sand about 12 inches thick. Between depths of 12 and 30 inches is reddish brown, mildly alkaline sandy clay loam and between depths of 30 and 50 inches is red, mildly alkaline sandy clay loam. The underlying material, to a depth of 70 inches, is red, mildly alkaline fine sandy loam.

Springer soils have a surface layer of brown, mildly alkaline loamy fine sand about 18 inches thick. Between depths of 18 and 31 inches is reddish brown, mildly alkaline fine sandy loam; between depths of 31 and 50 inches is yellowish red, mildly alkaline fine sandy loam, and between depths of 50 and 68 inches is light reddish brown, mildly alkaline loamy fine sand. The underlying material, to a depth of 80 inches, is brown, moderately alkaline fine sandy loam.

Among the minor soils in this map unit are Altus soils, Miles fine sandy loam Rotan soils, and Winters soils.

This map unit is used for cropland and range. The potential is medium to high for row crops and small grain. The potential is high for native range plants. Yields of forage are good during favorable years. The potential is high for most urban uses and medium for recreation uses. The loamy fine sand surface layer is the most limiting feature.

Land use considerations

The map units in Knox County vary widely in their potential for major land uses as indicated in table 2. For each land use the ratings of the potential of each unit are portrayed in relation to other units. Kinds of soil limitations are also indicated in general terms. The ratings of soil potential are based in the assumption that practices in common use in the survey area are being used to overcome soil limitations. These ratings reflect the ease of overcoming the soil limitations and the soil related problems that will continue after such practices are installed. The ratings do not consider location in relation to existing transportation systems or other facilities.

Kinds of land uses considered include cultivated crops, range, urban development, and recreation. Cultivated crops in the survey area include cotton, grain sorghum, and wheat, as well as special crops, such as vegetables. Range refers to land that grows native plants for grazing. Urban development includes land that is used as residential, commercial, and industrial sites. Recreation includes camp areas, picnic areas, playgrounds, and paths and trails.

The kinds of soils, limited rainfall, and the availability of irrigation water generally influence the agricultural use of land in Knox County.

About 58 percent of the county is used for range, about 40 percent for cultivated crops, and about 2 percent for other uses. According to table 2, the potential is high for cropland in about 59 percent of the county and low in about 41 percent. Table 2 also indicates the potential is high for range in about 63 percent of the county, medium in about 30 percent, and low in 7 percent.

The trend in recent years has been a slight decrease in the acreage used for range and a slight increase in the acreage used for cropland, special crops, urban development, and recreation.

The urban areas and most rural residences are in the Miles-Rotan, Tillman-Hollister-Wichita, and Miles-Springer map units, in which the potential for urban development is medium to high. The soils in these map units have few limitations or limitations that can be overcome for most urban uses. Rotan, Tillman, Hollister, and Wichita soils have clay in the lower layers that cause them to shrink and swell, which is a limitation for building foundations, roads, and septic tank absorption fields. This limitation can be overcome by good design and careful installation procedures.

In most map units of the county the potential is high for producing native range plants. In the Knoco-Vernon and Cottonwood-Knoco map units the potential is low for cultivated crops, urban development, and recreation use but is medium for range. Water erosion, complex slopes, erratic drainage patterns, and low available water capacity are major limitations for range.

The Hardeman-Enterprise-Lincoln map unit is used mostly for range because of flooding and complex slopes. Small, nearly level tracts are use for cultivated crops. The potential is high for producing native range plants.

The Clairemont-Mangum map unit is used for range, and potential is high for producing native range plants. Potential is low for cultivated crops because the unit is subject to flooding.

In the Tillman-Hollister-Wichita map unit the potential is high for production of crops. The main crops are cotton, grain sorghum, and wheat. Some areas are used for range, and the potential is high for producing native range plants.

In the Miles-Rotan map unit the potential is high for crop production, and most areas are cultivated. Cotton, wheat, and grain sorghum are the main crops. The potential is high for irrigated crops and vegetables; however, the water supply is limited.

In the Miles-Springer map unit the potential is high for row crops and small grain. Some areas of this unit are hummocky and difficult to cultivate, and soil blowing is difficult to control. The potential is high for native range plants.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have profiles that are almost alike make up a *soil series*. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Wichita clay loam, 0 to 1 percent slopes is one of several phases within the Wichita series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes and soil associations.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Lincoln-Yahola complex, occasionally flooded, is an example.

A *soil association* is made up of soils that are geographically associated and are shown as one unit on the map because it is not practical to separate them. A soil association has considerable regularity in geographic pattern and in the kinds of soil that are a part of it. The extent of the soils can differ appreciably from one delineation to another; nevertheless, interpretations can be made for use and management of the soils. Knoco-Badland association, undulating is an example.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 3, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

1—Altus fine sandy loam, 0 to 1 percent slopes. This deep, well drained, nearly level soil is on uplands. Slopes are plane and average about 0.5 percent. Areas are oval to irregular in shape and range from 10 to 400 acres in size.

The surface layer is dark brown, neutral fine sandy loam about 10 inches thick. Between depths of 10 and 18 inches is dark brown, neutral fine sandy loam. Between the depths of 18 and 29 inches is reddish brown, mildly alkaline sandy clay loam. Between depths of 29 and 47 inches is reddish brown, moderately alkaline sandy clay loam, and between depths of 47 and 62 inches is reddish brown, calcareous, moderately alkaline fine sandy loam. The underlying material to a depth of 80 inches is yellowish red, calcareous, moderately alkaline fine sandy loam that contains a few films and soft bodies of calcium carbonate.

Surface runoff is slow. Permeability is moderate, and available water capacity is high. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Tilth is good, and this soil can be worked over a wide range of moisture conditions. The root zone is deep and easily penetrated by plant roots.

Included with this soil in mapping are small areas of Miles, Rotan, and Winters soils. The Miles soils are at a slightly higher elevation than the Altus soil. Rotan and Winters soils are at the same elevation. Localized soil blowing is evident in spots. Included soils make up less than 15 percent of any area of this map unit.

This soil is used mainly for cropland. The potential is high for row crops and small grain. Where this soil is irrigated, the potential is high for vegetable production. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of tall and mid grasses.

This soil has high potential for urban uses. Low strength of the soil limits its suitability for streets and roads. Seepage is a problem where sewage lagoons are constructed. The potential is high for recreation uses. Capability subclass IIe nonirrigated and IIe irrigated; Sandy Loam range site.

2—Aspermont silty clay loam, 1 to 3 percent slopes. This deep, well drained, gently sloping soil is on uplands. Slopes are convex and average about 2 percent. Areas are irregular in shape and range from 10 to 300 acres in size.

The surface layer is light brown, calcareous, moderately alkaline silty clay loam about 8 inches thick. Between depths of 8 and 18 inches is reddish brown, calcareous, moderately alkaline silty clay loam that contains common concretions of calcium carbonate. Between depths of 18 and 36 inches is yellowish red, calcareous, moderately alkaline silty clay loam that contains about 20 percent, by volume, soft bodies and concretions of calcium carbonate. The underlying material, to a depth of 60 inches, is red, calcareous, moderately alkaline silty clay loam that contains about 5 percent, by volume, soft bodies and concretions of calcium carbonate.

Surface runoff is medium. Permeability is moderate, and available water capacity is medium. The hazard of water erosion and soil blowing are moderate. Tilth is good, and this soil can be worked over a wide range of moisture conditions. The root zone is moderately deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Owens and Knoco soils. These included soils are at the same elevation as the Aspermont soils. They make up less than 20 percent of any area of this map unit.

This soil is used as cropland and range. The potential is medium for row crops and small grain. It is limited by the depth of soil and by the slope. Terraces and contour cultivation help to control erosion. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains tilth and productivity. The potential is medium for native range plants. The potential plant community is a mixture of mid and short grasses.

This soil has medium potential for most urban uses. The shrinking and swelling, low strength, corrosivity to uncoated steel, and slow percolation rate are the most limiting features. The potential is medium for recreation uses. The most limiting features are the silty clay loam surface layer and the slope. Capability subclass IIIe; Clay Loam range site.

3—Aspermont silty clay loam, 3 to 5 percent slopes. This deep, well drained, gently sloping soil is on uplands. Slopes are convex and average about 4 percent. Areas are round to irregular in shape and range from 10 to 400 acres in size.

The surface layer is yellowish red, calcareous, moderately alkaline silty clay loam about 7 inches thick. Between depths of 7 and 15 inches is yellowish red, calcareous, moderately alkaline silty clay loam that contains a few concretions of calcium carbonate. Between depths of 15 and 36 inches is reddish yellow, calcareous, moderately alkaline silty clay loam that contains about 17 percent, by volume, soft bodies and concretions of calcium carbonate. The underlying material, to a depth of 60 inches, is reddish yellow, calcareous, moderately alkaline silty clay loam that contains a few soft bodies and concretions of calcium carbonate.

Surface runoff is medium. Permeability is moderate, and available water capacity is medium. The hazards of water erosion and soil blowing are moderate. Tilth is good, and the soil can be worked in a wide range of moisture conditions. The root zone is moderately deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of more sloping Owens and Vernon soils near drainageways. They make up less than 20 percent of any area of this map unit.

This soil is used as cropland and range. The potential is medium for row crops and small grain. It is limited by the depth of soil and by the slope. Terraces and contour cultivation help to control erosion. Crop residue left on the soil surface helps conserve moisture, reduces soil temperature, and maintains tilth and productivity. The potential is medium for native range plants. The potential plant community is a mixture of mid and short grasses.

This soil has high potential for most urban uses. Shrinking and swelling, low strength, corrosivity to uncoated steel, and a slow percolation rate are the most limiting features. The potential is medium for recreation uses. The most limiting features are the silty clay loam surface layer and the slope. Capability subclass IVe; Clay Loam range site.

4—Aspermont silty clay loam, 5 to 12 percent slopes. This deep, well drained, sloping to strongly sloping soil is on uplands. Slopes are convex and average about 7 percent. Areas are long and narrow in shape and range from 10 to 200 acres in size.

The surface layer is reddish brown, calcareous, moderately alkaline silty clay loam about 6 inches thick. Between depths of 6 and 12 inches is yellowish red, calcareous, moderately alkaline silty clay loam. Between depths of 12 and 25 inches is reddish yellow, calcareous, moderately alkaline silty clay loam that contains about 17 percent, by volume, soft bodies and concretions of calcium carbonate. The underlying material is red, calcareous shaly clay.

Surface runoff is rapid. Permeability is moderate, and available water capacity is medium. The hazard of water erosion is severe, and the hazard of soil blowing is moderate. The root zone is moderately deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Knoco and Owens soils. These included soils are at the same elevation as the Aspermont soils. They make up less than 20 percent of any area of this map unit.

This soil has low potential for farming and for recreation and urban uses. The complex, steep slope is the most limiting feature.

This soil is used mainly as range. The potential is medium for native range plants. The potential plant community is mid and short grasses. Capability subclass VIe; Clay Loam range site.

5—Clairemont silt loam, occasionally flooded. This deep, well drained, nearly level soil is on flood plains of streams. Slopes are plane and average about 0.5 percent.

This map unit is inundated only once in every several years. Areas are long and narrow or oval in shape and range from 10 to 400 acres in size.

The surface layer is red, calcareous, moderately alkaline silt loam about 10 inches thick. Between depths of 10 and 38 inches is reddish brown, calcareous, moderately alkaline silty clay loam. Between depths of 38 and 46 inches is red, calcareous, moderately alkaline silty clay loam. The underlying material, to a depth of 60 inches, is red, calcareous, moderately alkaline loam.

Surface runoff is slow. Permeability is moderate, and available water capacity is high. The hazards of water erosion and soil blowing are slight. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are areas of Mangum and Yahola soils. The Mangum soils are in depressions, and the Yahola soils are at a slightly higher elevation than the Clairemont soils. Included soils make up less than 10 percent of any area of this map unit.

This soil is mainly cropland. The potential is high for row crops and small grain. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains tilth and productivity. The potential is high for pasture production. It is high for native range plants. The potential plant community is a mixture of tall and mid grasses.

This soil has low potential for most urban uses; flooding is the most limiting feature. The potential is medium for recreation uses; flooding and dust are the most limiting features. Capability subclass IIw nonirrigated and IIw irrigated; Loamy Bottomland range site.

6—Clairemont silt loam, frequently flooded. This deep, well drained, nearly level soil is on flood plains of streams (fig. 5). Slopes are plane and average about 0.5 percent. This map unit is inundated 2 to 4 times each year. Areas are long and narrow or oval and range from 20 to 800 acres in size.

The surface layer is red, calcareous, moderately alkaline silt loam about 12 inches thick. Between depths of 12 and 36 inches is red, calcareous, moderately alkaline silty clay loam. Between depths of 36 and 42 inches is reddish brown, calcareous, moderately alkaline silty clay loam. Between depths of 42 and 56 inches is light red, calcareous, moderately alkaline silty clay loam. The underlying material, to a depth of 80 inches, is reddish brown, calcareous, moderately alkaline silty clay loam.

Surface runoff is slow. Permeability is moderate, and available water capacity is high. The hazards of water erosion and soil blowing are slight. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are areas of Mangum and Yahola soils. The Mangum soils are in depressions, and the Yahola soils are at a slightly higher elevation than the Clairemont soils. Included soils make up less than 10 percent of any area of this map unit.

This soil is used for range. The potential is medium for native range plants. The potential plant community is a mixture of mid and tall grasses with scattered areas of elm and cottonwood trees.

This soil has low potential for farming and for urban use; flooding is the most limiting feature. The potential is medium for recreation; flooding and dust are the most limiting features. Capability subclass Vw; Loamy Bottomland range site.

7—Cobb fine sandy loam, 0 to 1 percent slopes. This moderately deep, well drained, nearly level soil is on uplands. Slopes are mostly convex and average about 0.5 percent. Areas are irregular in shape and range from 20 to 400 acres in size.

The surface layer is reddish brown, neutral fine sandy loam about 8 inches thick. Between depths of 8 and 22 inches is reddish brown, neutral sandy clay loam. Between depths of 22 and 32 inches is red, mildly alkaline sandy clay loam. The underlying material is red and gray, weakly cemented sandstone.

Surface runoff is slow. Permeability is moderate, and available water capacity is low. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is moderately deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Cosh, Tillman, and Wichita soils. The Cosh soils are at a slightly higher elevation, and the Tillman and Wichita soils are at a lower elevation than the Cobb soils. Included soils make up less than 15 percent of any area of this map unit.

This soil has medium potential for row crops and small grain. Soil depth is a limitation. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity.

This soil is used mainly as range. The potential is high for native range plants. The potential plant community is a mixture of tall, mid, and short grasses.

This soil has low potential for urban use. Depth to cemented sandstone is the most limiting feature. The potential is high for most recreation uses. Depth to cemented sandstone also limits some playground uses. Capability subclass IIe nonirrigated and IIe irrigated; Sandy Loam range site.

8—Cobb fine sandy loam, 1 to 3 percent slopes. This moderately deep, well drained, nearly level soil is on uplands. Slopes are mostly convex and average about 1.5 percent. Areas are oval to irregular in shape and range from 20 to 1,000 acres in size.

The surface layer is reddish brown, neutral fine sandy loam about 6 inches thick. Between depths of 6 and 24 inches is reddish brown, neutral sandy clay loam. Between depths of 24 and 34 inches is reddish brown, neutral sandy clay loam. The underlying material is red, weakly cemented sandstone.

Surface runoff is medium. Permeability is moderate, and available water capacity is low. The hazards of water erosion and soil blowing are moderate. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is moderately deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Cosh and Vernon soils. Also included are small areas of a soil that is similar to the Cobb soil, but becomes calcareous in the lower part of the subsoil. The Cosh and Vernon soils are in slightly more sloping areas. Included soils make up less than 15 percent of any area of this map unit.

This soil has medium potential for row crops and small grain. Soil depth is a limitation. Terraces and contour cultivation help to control erosion. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity.

This soil is used mainly as range. The potential is high for native range plants. The potential plant community is a mixture of tall, mid, and short grasses.

This soil has low potential for urban uses. Depth to cemented sandstone is the most limiting feature. The potential is high for most recreation uses. Depth to cemented sandstone limits some playground uses. Capability subclass IIIe nonirrigated and IIe irrigated; Sandy Loam range site.

9—Cosh fine sandy loam, 1 to 5 percent slopes. This shallow, well drained, gently sloping soil is on uplands. Slopes are convex and average about 2 percent. Areas are oval to irregular in shape and range from 10 to 200 acres in size.

The surface layer is reddish brown, mildly alkaline fine sandy loam about 6 inches thick. The subsoil is reddish brown, mildly alkaline sandy clay loam about 12 inches thick. The underlying material is red, weakly cemented sandstone.

Surface runoff is medium. Permeability is moderate, and available water capacity is very low. The hazards of water erosion and soil blowing are moderate. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is restricted by the shallow depth to sandstone.

Included with this soil in mapping are small areas of Cobb, Knoco, and Owens soils. Also included is a soil that is similar to the Cosh soil, but has a calcareous subsoil. The Cobb soils are in the less sloping areas. The Knoco and Owens soils are at the same elevation as the Cosh soils. Included soils make up less than 20 percent of any area of this map unit.

This soil is used mainly for range. The potential is high for native range plants. The potential plant community is a mixture of tall, mid, and short grasses. The potential is low for farming. The shallow root zone is a limitation that is difficult to overcome. Only close-spaced, high residue-producing crops should be grown. Crop residue left on the surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity.

This soil has low potential for urban use. Depth to cemented sandstone is the most limiting feature. The potential is high for most recreation uses. Depth to cemented sandstone also limits some playground uses. Capability subclass IVe nonirrigated and IVe irrigated; Sandy Loam range site.

10—Cottonwood-Knoco association, rolling. This association consists of rolling soils on uplands (fig. 6). These soils are well drained. Slopes range from 5 to 16 percent. Areas are broad and irregular in shape, are dissected with erratic patterns of secondary drainageways, and range from about 200 to several thousand acres in size.

The composition of this map unit is more variable than that of others in the survey area but has been controlled well enough to be interpreted for the expected use of the soils.

This association is about 45 percent Cottonwood soils, 25 percent Knoco soils, and 30 percent included soils and Badland.

The Cottonwood soils are on ridges. The surface layer is reddish brown, calcareous, moderately alkaline clay loam about 8 inches thick. The underlying material is white, weakly cemented gypsum.

Surface runoff is rapid on Cottonwood soils. Permeability is moderate, and available water capacity is very low. The hazard of water erosion is severe, and the hazard of soil blowing is moderate. The root zone is restricted by the very shallow depth to gypsum.

The Knoco soils are on side slopes. The surface layer is red, calcareous, moderately alkaline clay about 8 inches thick. The underlying material is red, calcareous, moderately alkaline clayey shale.

Surface runoff is rapid on Knoco soils. Permeability is very slow, and available water capacity is very low. The hazard of water erosion is severe, and the hazard of soil blowing is slight. The root zone is restricted by the very shallow depth to clayey shale.

Included with this association in mapping are Owens, Vernon, and Mangum soils. The Owens and Vernon soils are gently sloping to sloping. Mangum soils are along drainageways. Small areas of Badland are throughout this map unit.

This association is used for range, but the potential is low for native range plants. The potential plant community is a mixture of mid and short grasses. These soils are not suited to farming because of the very shallow root zone, the hazard of erosion, and complex slopes.

This association has low potential for recreation and urban uses. Complex slopes, dust, depth to rock, and shrink-swell hazard are the most limiting features. Capability subclass VIIs; Cottonwood part in Gyp range site, Knoco part in Shallow Clay range site.

11—Enterprise very fine sandy loam, 0 to 1 percent slopes. This deep, well drained, nearly level soil is on uplands. Slopes are plane and average about 0.5 percent. Areas are long and narrow or oval and range from 10 to 200 acres in size.

The surface layer is reddish brown, mildly alkaline very fine sandy loam about 16 inches thick. The subsoil is yellowish red, calcareous, moderately alkaline very fine sandy loam about 25 inches thick. The underlying material, to a depth of 72 inches, is reddish brown, calcareous, moderately alkaline very fine sandy loam.

Surface runoff is slow. Permeability is moderately rapid, and available water capacity is high. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Miles and Hardeman soils. The Miles and Hardeman soils are at a slightly higher elevation than the Enterprise soils. Included soils make up less than 10 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is high for row crops and small grain. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of mid and tall grasses.

This soil has high potential for urban use. Low strength of the soil limits suitability for streets and roads. Seepage is a problem where sewage lagoons are constructed. The potential is high for recreation uses. Capability subclass IIc nonirrigated, and capability class I irrigated; Sandy Loam range site.

12—Enterprise very fine sandy loam, 1 to 3 percent slopes. This deep, well drained, gently sloping soil is on uplands. Slopes are slightly concave and average about 2 percent. Areas are irregular in shape and range from 10 to 150 acres in size.

The surface layer is yellowish red, calcareous, moderately alkaline very fine sandy loam about 10 inches thick. Between depths of 10 and 20 inches is yellowish red, calcareous, moderately alkaline very fine sandy loam. Between depths of 20 and 42 inches is reddish yellow, calcareous, moderately alkaline very fine sandy loam. The underlying material, to a depth of 70 inches, is reddish yellow, calcareous, moderately alkaline very fine sandy loam that contains soft bodies of calcium carbonate.

Surface runoff is medium. Permeability is moderately rapid, and available water capacity is high. The hazards of water erosion and soil blowing are moderate. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Hardeman and Miles soils. These included soils are at the same elevation as the Enterprise soils. They make up less than 20 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is high for row crops and small grain. Terraces and contour cultivation help to control erosion. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of mid and tall grasses.

This soil has high potential for urban uses. Low strength of the soil limits suitability for streets and roads. Seepage is a problem where sewage lagoons are constructed. The potential is high for recreation uses. Capability subclass IIe nonirrigated and IIe irrigated; Sandy Loam range site.

13—Hardeman fine sandy loam, 0 to 1 percent slopes. This deep, well drained, nearly level soil is on uplands. Slopes are plane or concave. Areas are long and narrow to irregular in shape and range from 10 to 200 acres in size.

The surface layer is reddish brown, mildly alkaline fine sandy loam about 13 inches thick. Between depths of 13 and 38 inches is reddish brown, calcareous, moderately alkaline fine sandy loam. Between depths of 38 and 66 inches is yellowish red, calcareous, moderately alkaline fine sandy loam. The underlying material, to a depth of 80 inches, is yellowish red, calcareous, moderately alkaline fine sandy loam that contains very fine concretions of calcium carbonate.

Surface runoff is slow. Permeability is moderately rapid, and available water capacity is medium. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Enterprise and Miles soils. The Enterprise soils are at a slightly lower elevation, and the Miles soils are at a slightly higher elevation than the Hardeman soils. Localized soil blowing is evident in spots. Included soils make up less than 15 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is high for row crops and small grain. Crop residue left on the soil surface helps prevent soil blowing, conserves moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of short, mid, and tall grasses.

This soil has high potential for urban uses. Low strength of the soil limits suitability for roads and streets. Seepage is a problem where sewage lagoons are constructed. The potential is high for recreation uses. Capability subclass IIe nonirrigated and IIe irrigated; Sandy Loam range site.

14—Hardeman fine sandy loam, 1 to 3 percent slopes. This deep, well drained, gently sloping soil is on uplands. Slopes are slightly concave and average about 2 percent. Areas are long and narrow to irregular in shape and range from 10 to 100 acres in size.

The surface layer is reddish brown, mildly alkaline fine sandy loam about 10 inches thick. Between depths of 10 and 18 inches is reddish brown, mildly alkaline fine sandy loam. Between depths of 18 and 28 inches is yellowish

red, moderately alkaline fine sandy loam. Between depths of 28 and 46 inches is reddish yellow, calcareous, moderately alkaline fine sandy loam. The underlying material, to a depth of 60 inches, is reddish yellow, calcareous, moderately alkaline fine sandy loam.

Surface runoff is medium. Permeability is moderately rapid, and available water capacity is medium. The hazards of water erosion and soil blowing are moderate. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Enterprise and Miles soils. Localized soil blowing is evident in spots. Included soils are intermingled with the Hardeman soil and are at the same elevation. They make up less than 15 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is high for row crops and small grain. Crop residue left on the soil surface helps prevent soil blowing, conserves moisture, slows the rate of runoff, reduces soil temperature, and maintains tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of tall, mid, and short grasses.

This soil has high potential for urban use. Low strength of the soil limits suitability for roads and streets. Seepage is a problem where sewage lagoons are constructed. The potential is high for recreation uses. Capability subclass IIIe nonirrigated and IIe irrigated; Sandy Loam range site.

15—Hardeman fine sandy loam, 3 to 5 percent slopes. This deep, well drained, gently sloping soil is on uplands. Slopes are concave and convex and average about 3.7 percent. Areas are irregular in shape and range from 10 to 200 acres in size.

The surface layer is reddish brown, calcareous, moderately alkaline fine sandy loam about 14 inches thick. Between depths of 14 and 32 inches is yellowish red, calcareous, moderately alkaline fine sandy loam. Between depths of 32 and 44 inches is yellowish red, calcareous, moderately alkaline fine sandy loam that contains many concretions of calcium carbonate. The underlying material, to a depth of 80 inches, is yellowish red, calcareous, moderately alkaline fine sand.

Surface runoff is medium. Permeability is moderately rapid, and available water capacity is medium. The hazards of water erosion and soil blowing are moderate. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Enterprise and Miles soils. Localized soil blowing is evident in spots. The included soils are intermingled with the Hardeman soils and are at the same elevation. They make up less than 15 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is medium for row crops and small grain. Crop residue left on the soil surface helps prevent soil blowing, conserves moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of short, mid, and tall grasses.

This soil has high potential for urban use. Low strength of the soil limits suitability for roads and streets. Seepage is a problem where sewage lagoons are constructed. The potential is high for recreation uses. Slope limits some playground uses. Capability subclass IIIe nonirrigated and IIIe irrigated; Sandy Loam range site.

16—Hardeman fine sandy loam, 5 to 12 percent slopes. This deep, well drained, sloping to strongly sloping soil is on uplands (fig. 7). Slopes are convex and average about 8 percent. Areas are long and narrow to irregular in shape and range from 10 to 400 acres in size.

The surface layer is reddish brown, calcareous, moderately alkaline fine sandy loam about 13 inches thick. Between depths of 13 and 42 inches is yellowish red, calcareous, moderately alkaline fine sandy loam. The underlying material, to a depth of 60 inches, is reddish yellow, calcareous, moderately alkaline fine sandy loam that has films and threads of calcium carbonate.

Surface runoff is medium. Permeability is moderately rapid, and available water capacity is medium. The hazard of water erosion is severe, and the hazard of soil blowing is moderate. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Enterprise and Owens soils. The included soils are intermingled with and are at the same elevation as the Hardeman soils. They make up less than 20 percent of any area of this map unit. Soil blowing is evident in spots.

This soil is used for range. The potential is high for native range plants. The potential plant community is a mixture of short, mid, and tall grasses.

This soil has medium potential for urban and recreation uses. The complex slope is the most limiting feature. Capability subclass VIe; Sandy Loam range site.

17—Hollister clay loam, 0 to 1 percent slopes. This deep, well drained, nearly level soil is on uplands. Slopes are plane and average less than 0.5 percent. Areas are long and narrow to oval and range from 20 to several hundred acres in size.

The surface layer is dark brown, moderately alkaline clay loam about 6 inches thick. Between depths of 6 and 37 inches is dark brown, calcareous, moderately alkaline clay. Between depths of 37 and 62 inches is dark brown, calcareous, moderately alkaline clay that contains very fine concretions of calcium carbonate. Between depths of 62 and 80 inches is red, calcareous, moderately alkaline clay that contains about 20 percent, by volume, soft bodies and concretions of calcium carbonate.

Surface runoff is slow. Permeability is slow, and available water capacity is high. The hazard of water erosion and soil blowing are slight. Tilth is good, but the soil will compact if worked when wet. The root zone is deep, but penetration by plant roots is difficult because of the clay content.

Included with this soil in mapping are small areas of intermingled Rotan, Sagerton, Tillman, Tobosa, and Wichita soils. These included soils are all at the same elevations as the Hollister soil. They make up less than 15 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is high for row crops and small grain. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of short and mid grasses.

This soil has low potential for most urban uses. Shrinking and swelling, corrosivity to uncoated steel, low strength, and slow percolation rate are the most limiting features. The potential is medium for recreation uses. The most limiting features are the clay loam surface layer and the slow percolation rate. Capability subclass IIc nonirrigated and capability class I irrigated; Clay Loam range site.

18—**Knoco-Badland association, undulating.** This association of undulating soils is on uplands (fig. 8). These soils are well drained. Slopes range from 1 to 8 percent. Areas are irregularly shaped and range from 25 to several thousand acres in size. The Knoco soils are very shallow and are on benches and divides between drains, they are intermingled with Badlands, or barren areas, throughout this map unit. Geologic erosion is active in many of the Badland areas.

The composition of this map unit is more variable than that of others in the survey area but has been controlled well enough to be interpreted for the expected use of the soils.

This association is about 34 percent Knoco soils, 41 percent Badland, and 25 percent included soils.

The Knoco soils have a surface layer of red, calcareous, moderately alkaline clay about 8 inches thick. The underlying material is red, calcareous, moderately alkaline clayey shale.

Surface runoff is rapid on Knoco soils. Permeability is very slow, and available water capacity is very low. The hazard of water erosion is severe, and the hazard of soil blowing is slight. The root zone is restricted by the very shallow depth to shale.

Badland is devoid of vegetation. Most areas have a surface layer of clayey shale that has a rocklike structure. Some areas have pavement of limestone fragments or quartz pebbles.

Included with this association in mapping are Owens, Vernon, and Mangum soils. The Owens and Vernon soils are gently sloping. Mangum soils are along drainageways. Also included in this map unit are a few areas that have steeper slopes.

This association is used for range, but the potential is low for native range plants. The potential plant community is a mixture of mid and short grasses. These soils are not suited to farming because of the very shallow root zone, the hazard of erosion, and complex slopes.

This association has low potential for recreation and urban uses. Areas of Badland, the clay surface layer, depth of the soil, shrinking and swelling, slow percolation, and complex slopes are the most limiting features. Capability subclass VIIs; Shallow Clay range site.

19—**Lincoln fine sand, frequently flooded.** This deep, somewhat excessively drained, nearly level soil is on flood plains of major rivers (fig. 9). Slopes are plane and average less than 0.5 percent. This soil is inundated 1 to 2 times in each year. It consists of long and narrow bands adjacent to rivers or oval areas on bends of rivers. Areas range from 10 to 100 acres in size.

The surface layer is yellowish red, calcareous, moderately alkaline fine sand about 8 inches thick. Between depths of 8 and 50 inches is reddish yellow, calcareous, moderately alkaline fine sand. The underlying material, to a depth of 70 inches, is yellowish red, calcareous, moderately alkaline loamy fine sand.

Surface runoff is slow. Permeability is rapid, and available water capacity is low. The hazard of water erosion is slight, and the hazard of soil blowing is severe. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Clairemont, Mangum, and Yahola soils in slight depressions. Included soils make up less than 20 percent of any area of this map unit.

This soil is used for range. The potential is high for native range plants. The potential plant community is a mixture of mid and tall grasses and scattered areas of elm and cottonwood trees.

This soil has low potential for farming and for recreation and urban uses. Flooding is the most limiting feature. Capability subclass Vw; Sandy Bottomland range site.

20—**Lincoln-Yahola complex, occasionally flooded.** This complex of nearly level to hummocky soils is on flood plains of rivers. These soils are deep and well drained. Slopes average about 1 percent. Areas are long and narrow to oval, contain many small mounds and hummocks, and range from 10 to 100 acres in size. Areas of this complex are inundated by floodwater about once in every five years.

This complex is about 45 percent Lincoln soils, 40 percent Yahola soils, and 15 percent included alluvial soils.

The Lincoln soils are on mounds. The surface layer is yellowish red, calcareous, moderately alkaline fine sand about 8 inches thick. Between depths of 8 and 20 inches is yellowish red, calcareous, moderately alkaline fine sand that contains a few thin strata of silt loam and fine sandy loam. The underlying material, to a depth of 70 inches, is reddish yellow, calcareous, moderately alkaline fine sand that contains a few thin strata of silt loam and fine sandy loam.

Surface runoff is medium on Lincoln soils. Permeability is rapid, and available water capacity is low. The hazard of water erosion is slight, and the hazard of soil blowing is severe. The root zone is deep and is easily penetrated by plant roots.

The Yahola soils make up the more level areas of this complex. The surface layer is reddish brown, calcareous, moderately alkaline fine sandy loam about 12 inches thick. Between depths of 12 and 36 inches is yellowish red, calcareous, moderately alkaline fine sandy loam that contains a few thin strata of very fine sandy loam and silt loam. The underlying material, to a depth of 70 inches, is reddish yellow, calcareous, moderately alkaline fine sandy loam.

Permeability of Yahola soils is moderately rapid, and available water capacity is medium. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. The root zone is deep and is easily penetrated by plant roots.

Included with this complex in mapping are small areas of Clairemont and Mangum soils. These included soils are less than 3 acres in size and make up less than 10 percent of the mapped areas.

The soils of this complex are used mainly for range. The potential is high for native range plants. The potential plant community is a mixture of mid and tall grasses and scattered areas of elm and cottonwood trees.

The soils of this complex have low potential for farming. Hummocks and the size and shape of areas are limiting features for cultivation.

The soils of this complex have low potential for urban use. Flooding is the most limiting feature. The potential is medium for recreation uses. The fine sand surface layer is an additional major limitation for the Lincoln soils. Capability subclass IVs nonirrigated and IVs irrigated; Lincoln part in Sandy Bottomland range site, Yahola part in Loamy Bottomland range site.

21—Mangum clay, occasionally flooded. This deep, nearly level, well drained soil is on flood plains of streams and rivers. Slopes are plane and average less than 0.5 percent. This soil is inundated about once in every five years. Areas are long and narrow to irregular in shape and range from 10 to 400 acres in size.

The surface layer is reddish brown, calcareous, moderately alkaline clay about 6 inches thick. Between depths of 6 and 14 inches is red, calcareous, moderately alkaline clay. Between depths of 14 and 32 inches is red, calcareous, moderately alkaline silty clay. The underlying material, to a depth of 60 inches, is red, calcareous, moderately alkaline clay that contains fine concretions and soft bodies of calcium carbonate.

Surface runoff is slow. Permeability is very slow, and available water capacity is high. This soil is difficult to cultivate and will compact if worked when wet. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. The root zone is deep, but penetration by plant roots is difficult because of the clay content.

Included with this soil in mapping are small areas of Clairemont and Yahola soils. These included soils are at a slightly higher elevation than the Mangum soils. They make up less than 20 percent of any area of this map unit.

This soil has medium potential for row crops and small grain. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains IIIw tilth and productivity.

This soil is used mainly as range. The potential is medium for native range plants. The potential plant community is a mixture of short and mid grasses.

This soil has low potential for recreation and urban uses. Flooding, shrinking and swelling, and the clay surface layer are the most limiting features. Capability subclass IIIw nonirrigated and IIIw irrigated; Clayey Bottomland range site.

22—Mangum clay, frequently flooded. This deep, moderately well drained, nearly level soil is on flood plains of streams and rivers. Slopes are plane and average less than 0.5 percent. This soil is inundated once or twice each year. Areas are long and narrow or irregular in shape and range from 10 to 800 acres in size.

The surface layer is reddish brown, calcareous, moderately alkaline clay about 10 inches thick. Between depths of 10 and 42 inches is reddish brown, calcareous, moderately alkaline clay that contains a few thin strata of silt loam in the lower 16 inches. The underlying material, to a depth of 60 inches, is reddish brown, calcareous, moderately alkaline clay that contains a few fine concretions of calcium carbonate.

Surface runoff is slow. Permeability is very slow, and available water capacity is high. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. The root zone is deep, but penetration by plant roots is difficult because of the clay content.

Included with this soil in mapping are small areas of Clairemont and Yahola soils. These included soils are at a slightly higher elevation than the Mangum soils. They make up less than 15 percent of any area of this map unit.

This soil is used for range. The potential is medium for native range plants. The potential plant community is a mixture of short and mid grasses.

This soil has low potential for farming and for recreation and urban uses. Flooding, shrinking and swelling, and the clay surface layer are the most limiting features. Capability subclass Vw; Clayey Bottomland range site.

23—Miles loamy fine sand, 0 to 3 percent slopes. This deep, well drained, nearly level to gently sloping soil is on uplands. Slopes are plane or convex and average about 1 percent. Areas are irregular to oval and range from 10 to 800 acres in size.

The surface layer is reddish brown, mildly alkaline loamy fine sand about 12 inches thick. Between depths of 12 and 30 inches is reddish brown, mildly alkaline sandy clay loam. Between depths of 30 and 50 inches is red, mildly alkaline sandy clay loam. The underlying material, to a depth of 70 inches, is red, mildly alkaline fine sandy loam.

Surface runoff is slow. Permeability is moderate, and available water capacity is high. The hazard of water erosion is slight, and the hazard of soil blowing is severe.

Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Miles fine sandy loam and Springer soils. The Miles fine sandy loam is in low areas, and the Springer soils are in raised areas or on mounds. Localized soil blowing is evident in spots. The included soils make up less than 20 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is high for row crops and small grain. Where this soil is irrigated, the potential is high for vegetable production. Crop residue left on the soil surface helps control soil blowing, conserves moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of mid and tall grasses.

This soil has high potential for urban use. Low strength of the soil limits suitability for streets and roads. Seepage is a problem where sewage lagoons are constructed. The potential is medium for recreation uses. The loamy fine sand surface layer is the most limiting feature. Capability subclass IIIe nonirrigated and IIIe irrigated; Loamy Sand range site.

24—Miles loamy fine sand, 3 to 5 percent slopes. This deep, well drained, gently sloping soil is on uplands. Slopes are convex and average about 3.8 percent. Areas are long and narrow to oval and range from 10 to 100 acres in size.

The surface layer is reddish yellow, neutral loamy fine sand about 8 inches thick. Between depths of 8 and 24 inches is reddish brown, neutral sandy clay loam. Between depths of 24 and 48 inches is red, neutral sandy clay loam, and between depths of 48 and 56 inches is red, mildly alkaline sandy clay loam. The underlying material, to a depth of 70 inches, is red, mildly alkaline fine sandy loam.

Surface runoff is medium. Permeability is moderate, and available water capacity is high. The hazard of water erosion is moderate, and the hazard of soil blowing is severe. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Miles fine sandy loam and Springer loamy fine sand. These included soils are at the same elevation as Miles loamy fine sand. Localized soil blowing is evident in spots. The included soils make up less than 20 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is medium for row crops and small grain. Crop residue left on the soil surface helps control soil blowing, conserves moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of mid and tall grasses.

This soil has high potential for urban use. Low strength of the soil limits suitability for streets and roads. Seepage is a problem where sewage lagoons are constructed. The potential is medium for recreation uses. The loamy fine sand surface layer is the most limiting feature. Capability subclass IVe nonirrigated and IVe irrigated; Loamy Sand range site.

25—Miles fine sandy loam, 0 to 1 percent slopes. This deep, well drained, neary level soil is on uplands. Slopes are plane and average about 0.5 percent. Areas are broad and irregular in shape and range from 10 to 800 acres in size.

The surface layer is reddish brown, neutral fine sandy loam about 10 inches thick. Between depths of 10 and 27 inches is reddish brown, neutral sandy clay loam. Between depths of 27 and 35 inches is red, neutral sandy clay loam, and between depths of 35 and 54 inches is red, mildly alkaline sandy clay loam. The underlying material, to a depth of 70 inches, is red, calcareous, moderately alkaline sandy clay loam that contains films and threads of calcium carbonate.

Surface runoff is slow. Permeability is moderate, and available water capacity is high. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Altus, Hardeman, and Winters soils. These included soils are at the same elevation as the Miles soils. Localized soil blowing is evident in spots. The included soils make up less than 15 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is high for row crops and small grain. Where this soil is irrigated, the potential is high for vegetable production (fig. 10). Crop residue left on the soil surface helps control soil blowing, conserves moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of mid and tall grasses.

This soil has high potential for recreation and urban uses. Low strength of the soil limits suitability for streets and roads. Seepage is a problem where sewage lagoons are constructed. Capability subclass IIe nonirrigated and IIe irrigated; Sandy Loam range site.

26—Miles fine sandy loam, 1 to 3 percent slopes. This deep, well drained, gently sloping soil is on uplands. Slopes are convex and average near 2 percent. Areas are broad and irregular in shape and range from 10 to 600 acres in size.

The surface layer is brown, neutral fine sandy loam about 8 inches thick. The subsoil is reddish brown, neutral sandy clay loam about 16 inches thick. The underlying material, to a depth of 64 inches, is red, calcareous, moderately alkaline sandy clay loam that contains films and threads of calcium carbonate.

Surface runoff is medium. Permeability is moderate, and available water capacity is high. The hazards of water erosion and soil blowing are moderate. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Altus, Hardeman, and Winters soils. These included soils are at the same elevation as the Miles soils. Localized soil blowing is evident in spots. The included soils make up less than 20 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is high for row crops and small grain. Where this soil is irrigated, the potential is high for vegetable production. Terraces and contour farming help conserve moisture and prevent erosion. Crop residue left on the soil surface helps control soil blowing, conserves moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of mid and tall grasses.

This soil has high potential for recreation and urban uses. Low strength of the soil limits suitability for streets and roads. Seepage is a problem where sewage lagoons are constructed. Capability subclass IIIe nonirrigated and IIe irrigated; Sandy Loam range site.

27—Randall clay. This deep, somewhat poorly drained, concave soil is on uplands. Slopes are less than 2 percent. This soil is inundated for several months each year except in dry years. Areas are oval and range from 8 to 270 acres in size.

The surface layer is dark gray, calcareous, moderately alkaline clay about 14 inches thick. Between depths of 14 and 37 inches is dark gray, calcareous, moderately alkaline clay. Between depths of 37 and 51 inches is gray, calcareous, moderately alkaline clay. The underlying material, to a depth of 70 inches, is gray, mottled, calcareous, moderately alkaline clay.

Surface runoff is slow, or the surface is ponded. Permeability is very slow, and available water capacity is high. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. The root zone is deep, but penetration is difficult because of the high clay content.

Included with this soil in mapping are small areas of Rotan, Sagerton, and Tobosa soils. These included soils are on the outer extremities of mapped areas. They make up less than 10 percent of any area of this map unit.

This soil is used mainly as range or as wildlife habitat. The potential is low for farming and for recreation and urban uses. Flooding is the most limiting feature. The potential is medium for native range plants in most years. During dry years forage production is good. Location, size, shape, and flooding limit the use of this soil. Vegetation consists of sedges, annuals, and short grasses. Capability subclass VIw; Lakebed range site.

28—Rotan clay loam, 0 to 1 percent slopes. This deep, well drained, nearly level soil is on uplands (fig. 11). Slopes are plane and average about 0.5 percent. Areas are oval to irregular in shape and range from 8 to 800 acres in size.

The surface layer is dark grayish brown, mildly alkaline clay loam about 10 inches thick. Between depths of 10 and 18 inches is dark grayish brown, mildly alkaline clay loam. Between depths of 18 and 24 inches is dark brown, moderately alkaline clay. Between depths of 24 and 36 inches is dark brown, calcareous, moderately alkaline clay that contains a few fine concretions of calcium carbonate; between depths of 36 and 62 inches is brown, calcareous, moderately alkaline clay that contains about 40 percent, by volume, soft bodies and concretions of calcium carbonate. The underlying material, to a depth of 70 inches, is yellowish red, calcareous, moderately alkaline clay that contains about 10 percent, by volume, soft bodies and concretions of calcium carbonate.

Surface runoff is slow. Permeability is moderately slow, and available water capacity is high. The hazards of water erosion and soil blowing are slight. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Hollister, Rowena, and Sagerton soils. These included soils are at the same elevation as the Rotan soils. They make up less than 20 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is high for row crops and small grain. Where this soil is irrigated, the potential is high for vegetable production. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of short and mid grasses.

This soil has medium potential for urban use. The corrosivity to uncoated steel, shrinking and swelling, low strength, and slow percolation rate are the most limiting features. The potential is medium for recreation uses. The clay loam surface layer and the slow percolation rate are the most limiting features. Capability subclass IIc nonirrigated and capability class I irrigated; Clay Loam range site.

29—Rotan-Winters-Miles complex, 0 to 1 percent slopes. This complex of nearly level soils is on uplands. These soils are deep and well drained. Areas are irregular in shape, contain many low mounds and ridges that are irregularly corrugated or wrinkled, and range from about 20 to several hundred acres in size.

This complex is about 40 percent Rotan soils, 30 percent Winters soils, 25 percent Miles soils, and 5 percent included soils.

The Rotan soils are between mounds or ridges in slight depressions or level areas. The surface layer is dark gray, moderately alkaline clay loam about 8 inches thick. Between depths of 8 and 18 inches is dark grayish brown, moderately alkaline clay loam; between depths of 18 and

26 inches is dark grayish brown, moderately alkaline clay; between depths of 26 and 48 inches is brown, calcareous, moderately alkaline clay that contains a few very fine concretions of calcium carbonate; between depths of 48 and 54 inches is brown, calcareous, moderately alkaline clay that contains about 3 percent, by volume, concretions of calcium carbonate; and between depths of 54 and 62 inches is brown, calcareous, moderately alkaline clay that contains about 20 percent, by volume, soft bodies and concretions of calcium carbonate. The underlying material, to a depth of 70 inches, is reddish yellow, calcareous, moderately alkaline clay. It contains about 30 percent, by volume, soft bodies and concretions of calcium carbonate.

Surface runoff is slow on Rotan soils. Permeability is moderately slow, and available water capacity is high. The hazards of water erosion and soil blowing are slight. The Winters soils are on low mounds and ridges. The surface layer is reddish brown, mildly alkaline fine sandy loam about 8 inches thick. Between depths of 8 and 14 inches is reddish brown, mildly alkaline fine sandy loam; between depths of 14 and 27 inches is red, mildly alkaline sandy clay loam; between depths of 27 and 44 inches is red, mildly alkaline sandy clay; and between depths of 44 and 62 inches is reddish brown, mildly alkaline sandy clay. The underlying material, to a depth of 70 inches, is yellowish red, calcareous, moderately alkaline sandy clay loam. It contains about 3 percent, by volume, calcium carbonate concretions.

Permeability is moderately slow in Winters soils, and available water capacity is high. The hazard of water erosion is slight, and the hazard of soil blowing is moderate.

The Miles soils are on low mounds and ridges. The surface layer is yellowish red, neutral fine sandy loam about 10 inches thick. Between depths of 10 and 20 inches is reddish brown, mildly alkaline sandy clay loam. Between depths of 20 and 54 inches is red, mildly alkaline sandy clay loam. The underlying material, to a depth of 70 inches, is red, calcareous, moderately alkaline sandy clay loam. It contains a few films and threads of calcium carbonate.

Permeability is moderate in Miles soils, and available water capacity is high. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Tilth is good, and this soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

The soils of this complex are used mainly for cropland. The potential is high for row crops and small grain. Where the soils are irrigated, the potential is high for vegetable production. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential plant community is a mixture of short, mid, and tall grasses.

The soils of this complex have high potential for urban use. Low strength of the soil restricts suitability for streets and roads. Shrinking and swelling and slow percolation are limiting features for the Rotan and Winters soils. The potential is medium for recreation uses. Slow percolation in the Rotan and Winters soils and the clay loam surface of the Rotan soils are the most limiting features. Capability subclass IIe nonirrigated and capability class I irrigated; Rotan part in Clay Loam range site, Winters and Miles parts in Sandy Loam range site.

30—Rowena clay loam, 0 to 1 percent slopes. This deep, well drained, nearly level soil is on uplands. Slopes are plane and average about 0.2 percent. Areas are irregular in shape and range from 10 to several hundred acres in size.

The surface layer is dark brown, calcareous, moderately alkaline clay loam about 8 inches thick. Between depths of 8 and 24 inches is dark grayish brown, calcareous, moderately alkaline clay. Between depths of 24 and 32 inches is dark brown, calcareous, moderately alkaline clay that contains few very fine concretions of calcium carbonate. Between depths of 32 and 40 inches is reddish brown, calcareous, moderately alkaline clay that contains about 20 percent, by volume, soft bodies and concretions of calcium carbonate. Between depths of 40 and 52 inches is yellowish red, calcareous, moderately alkaline clay that contains about 40 percent, by volume, soft bodies and concretions of calcium carbonate. The underlying material, to a depth of 70 inches, is reddish yellow, calcareous, moderately alkaline clay that contains about 15 percent, by volume, concretions of calcium carbonate.

Surface runoff is slow. Permeability is moderately slow, and available water capacity is high. The hazard of water erosion and soil blowing are slight. Tilth is good, but the soil compacts if worked when wet. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Rotan and Tobosa soils. These included soils are at the same elevation as the Rowena soils. They make up less than 20 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is high for row crops and small grain. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of short and mid grasses.

This soil has high potential for urban use. Shrinking and swelling and the slow percolation rate are the most limiting features. The potential is medium for recreation uses. The clay loam surface layer and slow percolation rate are the most limiting features. Capability subclass IIc nonirrigated and capability class I irrigated; Clay Loam range site.

31—Sagerton clay loam, 0 to 1 percent slopes. This deep, well drained, nearly level soil is on uplands. Slopes are plane and average about 0.4 percent. Areas are irregular to oval and range from 10 to several hundred acres in size.

The surface layer is dark brown, moderately alkaline clay loam about 8 inches thick. Between depths of 8 and 18 inches is reddish brown, moderately alkaline clay.

Between depths of 18 and 36 inches is red, calcareous, moderately alkaline clay that contains few very fine concretions of calcium carbonate below 22 inches. Between depths of 36 and 60 inches is light red, calcareous, moderately alkaline clay that contains about 35 percent, by volume, soft bodies and concretions of calcium carbonate. The underlying material, to a depth of 80 inches, is light red, calcareous, moderately alkaline clay that contains about 10 percent, by volume, soft bodies and concretions of calcium carbonate.

Surface runoff is slow. Permeability is moderately slow, and available water capacity is high. The hazards of water erosion and soil blowing are moderate. Tilth is good, but the soil compacts if worked when wet. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Rotan, Rowena, and Wichita soils. These included soils are at the same elevation as the Sagerton soils. They make up less than 15 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is high for row crops and small grain. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of short and mid grasses.

This soil has high potential for most urban uses. Shrinking and swelling, low strength for streets and roads, and the slow percolation rate are the most limiting features. The potential is medium for recreation uses. The clay loam surface layer and the slow percolation rate are the most limiting features. Capability subclass IIc nonirrigated and capability class I irrigated; Clay Loam range site.

32—Sagerton clay loam, 1 to 3 percent slopes. This deep, well drained, gently sloping soil is on uplands. Slopes are plane or convex and average about 2 percent. Areas are irregular in shape and range from 10 to 180 acres in size.

The surface layer is reddish brown, mildly alkaline clay loam about 8 inches thick. Between depths of 8 and 15 inches is reddish brown, calcareous, moderately alkaline clay loam; between depths of 15 and 28 inches is reddish brown, calcareous, moderately alkaline clay that contains a few very fine concretions of calcium carbonate; between depths of 28 and 47 inches is red, calcareous, moderately alkaline clay that contains a few fine concretions of calcium carbonate; and between depths of 47 and 64 inches is red, calcareous, moderately alkaline clay that contains about 20 percent, by volume, soft bodies and concretions of calcium carbonate.

Surface runoff is medium. Permeability is moderately slow, and available water capacity is high. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. Tilth is good, but the soil compacts if worked when wet. The root zone is deep and is easily penetrated by plant roots.

Included with some areas of this soil in mapping are small areas of Tillman and Wichita soils. These included soils are at the same elevation as the Sagerton soils. They make up less than 20 percent of any area of this map unit.

This soil is used for both cropland and range. The potential is high for row crops and small grain. Terraces and contour cultivation help to control erosion. Crop residue left on the soil surface helps to conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of short and mid grasses.

This soil has high potential for most urban uses. Shrinking and swelling, low strength for streets and roads, and the slow percolation rate are the most limiting features. The potential is medium for recreation uses. The clay loam surface layer and slow percolation rate are the most limiting features. Capability subclass IIe nonirrigated and IIe irrigated; Clay Loam range site.

33—Springer loamy fine sand, 0 to 3 percent slopes. This deep, well drained, nearly level to gently sloping soil is on uplands. Areas are oval to irregular in shape and range from 15 to 1,600 acres in size.

The surface layer is brown, mildly alkaline loamy fine sand about 18 inches thick. Between depths of 18 and 31 inches is reddish brown, mildly alkaline fine sandy loam. Between depths of 31 and 50 inches is yellowish red, mildly alkaline fine sandy loam. Between depths of 50 and 68 inches is light reddish brown, mildly alkaline loamy fine sand. The underlying material, to a depth of 80 inches, is brown, moderately alkaline fine sandy loam.

Surface runoff is slow. Permeability is moderately rapid, and available water capacity is medium. The hazard of water erosion is slight, and the hazard of soil blowing is severe. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Miles soils. The Miles soils are at the same elevation as the Springer soils. Localized soil blowing is evident in spots. The included soils make up less than 20 percent of any area of this map unit.

This soil is used as both cropland and range. The potential is medium for row crops and small grain. Crop residue left on the soil surface helps conserve moisture, prevents soil blowing, reduces soil temperature, and maintains productivity. The potential is high for native range plants. The potential plant community is a mixture of mid and tall grasses.

This soil has high potential for most urban uses. Cutbanks caving in shallow excavations is the most limiting feature. The potential is medium for recreation. The loamy fine sand surface layer is the most limiting feature. Capability subclass IVe nonirrigated and IIIe irrigated; Loamy Sand range site.

34—Tillman clay loam, 0 to 1 percent slopes. This deep, well drained, nearly level soil is on uplands. Slopes

are plane or convex and average about 0.5 percent. Areas are broad and irregular in shape and range from 20 to about 500 acres in size.

The surface layer is reddish brown, mildly alkaline clay loam about 7 inches thick. Between depths of 7 and 16 inches is reddish brown, moderately alkaline clay, and between depths of 16 and 56 inches is reddish brown, calcareous, moderately alkaline clay that contains a few soft bodies and concretions of calcium carbonate. The underlying material, to a depth of 80 inches, is yellowish red, calcareous, moderately alkaline clay that contains a few soft bodies, films, and threads of calcium carbonate.

Surface runoff is slow. Permeability is slow, and available water capacity is high. The hazards of water erosion and soil blowing are slight. Tilth is good, but the soil compacts if worked when wet. The root zone is deep, but penetration is difficult because of the high clay content.

Included with this soil in mapping are small areas of Hollister, Sagerton, and Wichita soils. These included soils are at the same elevation as the Tillman soils. They make up less than 20 percent of any area of this map unit.

This soil is used as both cropland and range. The potential is high for row crops and small grain. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity. The potential is medium for native range plants. The potential plant community is a mixture of short and mid grasses.

This soil has medium potential for urban use. Shrinking and swelling, low strength for streets and roads, and the slow percolation rate are the most limiting features. The potential is medium for recreation uses. The clay loam surface layer and slow percolation rate are the most limiting features. Capability subclass IIs nonirrigated and IIs irrigated; Clay Loam range site.

35—Tillman clay loam, 1 to 3 percent slopes. This deep, well drained, gently sloping soil is on uplands. Slopes are plane and average about 2 percent. Areas are broad and irregular in shape and range from 20 to about 400 acres in size.

The surface layer is reddish brown, moderately alkaline clay loam about 7 inches thick. Between depths of 7 and 18 inches is reddish brown, moderately alkaline clay; between depths of 18 and 32 inches is reddish brown, calcareous, moderately alkaline clay; and between depths of 32 and 47 inches is reddish brown, calcareous, moderately alkaline clay that contains a few soft bodies and concretions of calcium carbonate. The underlying material, to a depth of 62 inches, is dark red, calcareous, moderately alkaline clay that contains a few soft bodies of calcium carbonate.

Surface runoff is medium. Permeability is slow, and available water capacity is high. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. Tilth is good, but the soil compacts if worked when wet. The root zone is deep, but penetration by plant roots is difficult because of the high clay content.

Included with this soil in mapping are small areas of Hollister, Sagerton, and Wichita soils. These included soils are at the same elevation as the Tillman soils. They make up less than 20 percent of any area of this map unit.

This soil is used as both cropland and range. The potential is high for row crops and small grain. Terraces and contour cultivation are needed to help control erosion. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains tilth and productivity. The potential is medium for native range plants. The potential plant community is a mixture of short and mid grasses.

This soil has medium potential for urban use. Shrinking and swelling, low strength for streets and roads, and the slow percolation rate are the most limiting features. The potential is medium for recreation uses. The clay loam surface layer and the slow percolation rate are the most limiting features. Capability subclass IIIe nonirrigated and IIe irrigated; Clay Loam range site.

36—Tobosa clay, 0 to 1 percent slopes. This deep, well drained, nearly level soil is on uplands. Slopes are plane and average about 0.4 percent. Areas are broad and oval to irregular in shape and range from 20 to several hundred acres in size.

The surface layer is dark grayish brown, calcareous, moderately alkaline clay about 24 inches thick. Between depths of 24 and 45 inches is dark grayish brown, calcareous, moderately alkaline clay that contains a few very fine concretions of calcium carbonate. Between depths of 45 and 60 inches is brown, calcareous, moderately alkaline clay that contains a few soft bodies and fine concretions of calcium carbonate. Between depths of 60 and 70 inches is light brown, calcareous, moderately alkaline clay that contains 20 to 30 percent, by volume, soft bodies and concretions of calcium carbonate. The underlying material, to a depth of 80 inches, is pink, calcareous, moderately alkaline clay that contains about 50 percent, by volume, soft bodies and concretions of calcium carbonate.

Surface runoff is slow. Permeability is very slow, and available water capacity is high. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Tilth is good, but the soil compacts if worked when wet. The root zone is deep, but penetration is difficult because of the high clay content.

Included with this soil in mapping are small areas of Hollister, Rotan, and Sagerton soils. These included soils are at the same elevation as the Tobosa soils. They make up less than 10 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is high for row crops and small grain. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of short and mid grasses.

This soil has medium potential for urban development. Shrinking and swelling, low strength for streets and roads, and the slow percolation rate are the most limiting

features. The potential is medium for recreation use. The clay surface layer and slow percolation rate are the most limiting features. Capability subclass IIIs; Clay Flat range site.

37—Vernon clay, 1 to 3 percent slopes. This moderately deep, well drained, gently sloping soil is on uplands. Slopes are convex and average about 2 percent. Areas are irregular in shape and range from 10 to about 400 acres in size.

The surface layer is reddish brown, calcareous, moderately alkaline clay about 7 inches thick. Between depths of 7 and 23 inches is red, calcareous, moderately alkaline clay. The underlying material is red, calcareous, moderately alkaline clayey shale.

Surface runoff is medium. Permeability is very slow, and available water capacity is low. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. The root zone is moderately deep, but penetration by plant roots is difficult because of the high clay content.

Included with this soil in mapping are small areas of Aspermont, Owens, and Tillman soils. These included soils are at the same elevation as the Vernon soils. They make up less than 15 percent of any area of this map unit.

This soil has low potential for row crops and medium potential for small grain. Terraces and contour farming help prevent erosion. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity.

This soil is used mainly for range. The potential is medium for native range plants. The potential plant community is a mixture of short and mid grasses.

This soil has medium potential for urban use. Shrinking and swelling, low strength for streets and roads, and the slow percolation rate are the most limiting features. The potential is medium for recreation use. The clay surface layer and slow percolation rate are the most limiting features. Capability subclass IVe; Shallow Clay range site.

38—Vernon clay, 3 to 8 percent slopes. This moderately deep, well drained, gently sloping to sloping soil is on uplands. Slopes are convex and average about 6 percent. Areas are irregular in shape and range from 10 to several hundred acres in size.

The surface layer is reddish brown, calcareous, moderately alkaline clay about 8 inches thick. Between depths of 8 and 22 inches is reddish brown, calcareous, moderately alkaline clay. Between depths of 22 and 32 inches is reddish brown, calcareous, moderately alkaline clay that contains about 20 percent, by volume, fine shale fragments. The underlying material, to a depth of 60 inches, is weak red, calcareous, moderately alkaline clayey shale.

Surface runoff is rapid. Permeability is very slow, and available water capacity is low. The hazard of water erosion is severe, and the hazard of soil blowing is moderate. The root zone is moderately deep, but penetration by plant roots is difficult because of the high clay content.

Included with this soil in mapping are small areas of Aspermont and Owens soils. These included soils are at the same elevation as the Vernon soils. They make up less than 20 percent of any area of this map unit.

This soil is used for range. The potential is medium for native range plants. The potential plant community is a mixture of short and mid grasses. The potential is low for farming because of complex slopes, a limitation which is difficult to overcome.

This soil has medium potential for urban uses. Shrinking and swelling, low strength for streets and roads, the slope, and the slow percolation rate are the most limiting features. The potential is medium for recreation uses. The clay surface layer, the slope, and the slow percolation rate are the most limiting features. Capability subclass VIe; Shallow Clay range site.

39—Vernon-Owens-Knoco association, rolling. This association of rolling soils is on uplands (fig. 12). These soils are moderately deep, shallow, and very shallow and are well drained. Surface runoff is rapid. Slopes are convex and range from 5 to 16 percent. Areas are irregular in shape and range from 20 to several hundred acres in size.

The Vernon soils are mainly in the gently sloping to sloping areas, and the Owens and Knoco soils are mainly in the strongly sloping to moderately steep areas.

Areas of this map unit are larger and the composition is more variable than that of others in the survey area, but mapping has been controlled well enough to be interpreted for the expected use of the soils.

This association is about 37 percent Vernon soils, 27 percent Owens soils, 27 percent Knoco soils, and 9 percent included soils.

The Vernon soil has a surface layer of reddish brown, calcareous, moderately alkaline clay about 8 inches thick. Between depths of 8 and 24 inches is reddish brown, calcareous, moderately alkaline clay. Between depths of 24 and 32 inches is reddish brown, calcareous, moderately alkaline clay that contains about 20 percent, by volume, shale fragments. The underlying material, to a depth of 60 inches, is weak red, calcareous, moderately alkaline clayey shale.

Permeability is very slow, and available water capacity is low. The hazard of water erosion is severe, and the hazard of soil blowing is moderate. The root zone is moderately deep, but penetration by plant roots is difficult because of the high clay content.

The Owens soil has a surface layer of reddish brown, calcareous, moderately alkaline clay about 7 inches thick. Between depths of 7 and 15 inches is reddish brown, calcareous, moderately alkaline clay that contains a few soft bodies of calcium carbonate. The underlying material, to a depth of 40 inches, is reddish brown, calcareous, moderately alkaline clayey shale.

Permeability is very slow, and available water capacity is very low. The hazard of water erosion is severe, and the hazard of soil blowing is moderate. The root zone is shallow, and penetration by plant roots is difficult because of the high clay content.

The Knoco soil has a surface layer of red, calcareous, moderately alkaline clay about 8 inches thick. The underlying material, to a depth of 40 inches, is weak red, calcareous, moderately alkaline clayey shale.

Permeability is very slow, and available water capacity is very low. The hazard of water erosion is severe, and the hazard of soil blowing is moderate. The root zone is restricted by the very shallow depth to shale.

This association is used for range, and potential is medium for native range plants. The potential plant community is a mixture of mid and short grasses. These soils have low potential for farming. The complex slopes are limitations that are very difficult to overcome.

This association has low potential for urban use. Complex slopes, soil depth, shrinking and swelling, low strength for streets and roads, and the slow percolation rate are the most limiting features. The potential is low for recreation. The clay surface layer, dust, and slow percolation rate are the limiting features. Capability subclass VIe; Shallow Clay range site.

40—Weymouth Variant clay loam, 1 to 3 percent slopes. This moderately deep, well drained, gently sloping soil is on uplands. Slopes are convex and average about 2 percent. Areas are oval to irregular in shape and range from about 20 to 200 acres in size.

The surface layer is reddish brown, calcareous, moderately alkaline clay loam about 9 inches thick. Between depths of 9 and 20 inches is red, calcareous, moderately alkaline clay loam. Between depths of 20 and 32 inches is red, calcareous, moderately alkaline clay loam that contains about 15 percent, by volume, soft bodies and concretions of calcium carbonate. The underlying material is limestone bedrock.

Surface runoff is medium. Permeability is moderate, and available water capacity is medium. The hazards of water erosion and soil blowing are moderate. The root zone is moderately deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Tillman, Vernon, and Wichita soils. These included soils are intermingled with the Weymouth soils and are at the same elevation. They make up less than 20 percent of any area of this map unit.

This soil is used for range. The potential is medium for native range plants. The potential plant community is a mixture of short and mid grasses. The potential is medium for row crops and small grain. If this soil is cultivated, terraces and contour cultivation are needed to help prevent erosion and conserve moisture. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains soil tilth and productivity.

This soil has medium potential for most urban uses. Location, soil depth to limestone, and low strength for streets and roads are the most limiting features. The potential is medium for recreation uses. The clay loam surface layer is the most limiting feature. Depth to limestone limits some playground uses. Capability subclass IIIe; Clay Loam range site.

41—Weymouth Variant clay loam, 3 to 5 percent slopes. This moderately deep, well drained, gently sloping soil is on uplands. Slopes are convex and average about 3.5 percent. Areas are oval to irregular in shape and range from about 25 to 200 acres in size.

The surface layer is reddish brown, moderately alkaline clay loam about 6 inches thick. Between depths of 6 and 18 inches is dark red, calcareous, moderately alkaline clay loam that contains a few very fine concretions of calcium carbonate. Between depths of 18 and 22 inches is red, calcareous, moderately alkaline clay loam that contains about 5 percent, by volume, concretions of calcium carbonate. The underlying material is limestone bedrock.

Surface runoff is medium. Permeability is moderate, and available water capacity is low. The hazards of water erosion and soil blowing are moderate. The root zone is moderately deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Cottonwood, Owens, and Vernon soils. Also included is a soil that is similar to the Weymouth Variant soil but is underlain by gypsum. These included soils are intermingled with the Weymouth Variant and are at the same elevation. They make up less than 20 percent of any area of this map unit.

This soil is used for range. The potential is medium for native range plants. The potential plant community is a mixture of short and mid grasses. The potential is medium to low for row crops and small grains. If this soil is cultivated, terraces and contour farming are needed to help prevent erosion and conserve moisture. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains tilth and productivity.

This soil has medium potential for most urban uses. Location, depth to limestone, and low strength for streets and roads are the most limiting features. The potential is medium for recreation uses. The clay loam surface layer is the most limiting feature. Depth to limestone limits some playground uses. Capability subclass IVe; Clay Loam range site.

42—Wichita clay loam, 0 to 1 percent slopes. This deep, well drained, nearly level soil is on uplands. Slopes are plane and average about 0.4 percent. Areas are oval to irregular in shape and range from about 20 to 500 acres in size.

The surface layer is reddish brown, mildly alkaline clay loam about 8 inches thick. Between depths of 8 and 17 inches is reddish brown, mildly alkaline clay loam. Between depths of 17 and 38 inches is reddish brown, calcareous, moderately alkaline clay that contains a few films and threads of calcium carbonate. Between depths of 38 and 52 inches is red, calcareous, moderately alkaline clay that contains a few concretions of calcium carbonate. The underlying material, to a depth of 70 inches, is red, calcareous, moderately alkaline clay that contains 10 percent, by volume, soft bodies and concretions of calcium carbonate.

Surface runoff is slow. Permeability is moderately slow, and available water capacity is high. The hazards of water erosion and soil blowing are slight. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Hollister, Sagerton, Tillman, and Vernon soils. The included soils are intermingled and are at the same elevation as the Wichita soils. They make up less than 10 percent of any area of this map unit.

This soil is used both as cropland and range. The potential is high for row crops and small grain. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of short and mid grasses.

This soil has high potential for most urban uses. Shrinking and swelling, low strength for streets and roads, and the slow percolation rate are the most limiting features. The potential is medium for recreation uses. The clay loam surface layer and slow percolation rate are limiting features. Capability subclass IIc nonirrigated and capability class I irrigated; Clay Loam range site.

43—Wichita clay loam, 1 to 3 percent slopes. This deep, well drained, gently sloping soil is on uplands. Slopes are convex and average about 2 percent. Areas are oval to irregular in shape and range from about 15 to 600 acres in size.

The surface layer is reddish brown, mildly alkaline clay loam about 8 inches thick. Between depths of 8 and 20 inches is reddish brown, calcareous, moderately alkaline clay loam. Between depths of 20 and 46 inches is reddish brown, calcareous, moderately alkaline clay that contains about 5 percent, by volume, soft bodies of calcium carbonate in the lower 18 inches. Between depths of 46 and 62 inches is reddish brown, calcareous, moderately alkaline clay that contains a few soft bodies and concretions of calcium carbonate. The underlying material, to a depth of 70 inches, is red, calcareous, moderately alkaline clay.

Surface runoff is medium. Permeability is moderately slow, and available water capacity is high. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Hollister, Sagerton, and Tillman soils. The included soils are intermingled with the Wichita soil and at the same elevation. They make up less than 15 percent of any area of this map unit.

This soil is used both as cropland and range. The potential is high for row crops and small grain. Terraces and contour cultivation are needed to help prevent erosion. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of short and mid grasses.

This soil has high potential for most urban uses. Shrinking and swelling, low strength for streets and roads, and the slow percolation rate are the most limiting features. The potential is medium for recreation uses. The clay loam surface layer and slow percolation rate are limiting features. Capability subclass IIe nonirrigated and IIe irrigated; Clay Loam range site.

44—Wichita clay loam, 3 to 5 percent slopes. This deep, well drained, gently sloping soil is on uplands. Slopes are convex and average about 4 percent. Areas are irregular in shape and range from about 10 to 75 acres in size.

The surface layer is reddish brown, mildly alkaline clay loam about 8 inches thick. Between depths of 8 and 20 inches is reddish brown, calcareous, moderately alkaline clay loam. Between depths of 20 and 38 inches is red, calcareous, moderately alkaline clay that contains a few fine concretions of calcium carbonate. Between depths of 38 and 62 inches is red, calcareous, moderately alkaline clay that contains a few films, threads, soft bodies, and concretions of calcium carbonate. The underlying material, to a depth of 80 inches, is light red, calcareous, moderately alkaline clay that contains about 15 percent, by volume, soft bodies and concretions of calcium carbonate.

Surface runoff is medium. Permeability is moderately slow, and available water capacity is high. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Aspermont, Sagerton, and Tillman soils. The Aspermont soils are at the same elevation as the Wichita soil; the Sagerton and Tillman soils are in less sloping areas. The included soils make up less than 15 percent of any area of this map unit.

This soil is used mainly for range. The potential is high for native range plants. The potential plant community is a mixture of short and mid grasses.

Where this soil is cultivated, the potential is high for row crops and small grain. Terraces and contour cultivation are needed to help prevent erosion and conserve moisture. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains tilth and productivity.

This soil has high potential for most urban uses. Shrinking and swelling, low strength for streets and roads, the slope, and slow percolation rate are the most limiting features. The potential is medium for recreation uses. The clay loam surface layer, the slope, and slow percolation rate are the limiting features. Capability subclass IIIe nonirrigated and IIIe irrigated; Clay Loam range site.

45—Winters fine sandy loam, 0 to 1 percent slopes. This deep, well drained, nearly level soil is on uplands. Slopes are plane or convex and average about 0.5 percent.

Areas are oval to irregular in shape and range from 15 to about 500 acres in size.

The surface layer is reddish brown, neutral fine sandy loam about 10 inches thick. Between depths of 10 and 20 inches is reddish brown, mildly alkaline sandy clay. Between depths of 20 and 48 inches is red, mildly alkaline sandy clay. The underlying material, to a depth of 70 inches, is light red, calcareous, moderately alkaline sandy clay that contains a few very fine concretions of calcium carbonate.

Surface runoff is slow. Permeability is moderately slow, and available water capacity is high. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Miles and Sagerton soils. The Miles soils are in slightly raised areas, and the Sagerton soils are at a slightly lower elevation than the Winters soil. These included soils make up less than 10 percent of any area of this map unit.

This soil is used mainly as cropland. The potential is high for row crops and small grain. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of short, mid, and tall grasses.

This soil has high potential for most urban uses. Shrinking and swelling, low strength for streets and roads, and the slow percolation rate are the most limiting features. The potential is high for recreation uses. The slow percolation rate limits some uses for camp areas and playgrounds. Capability subclass IIe nonirrigated and capability class I irrigated; Sandy Loam range site.

46—Yahola fine sandy loam, occasionally flooded. This deep, well drained, nearly level soil is on flood plains of rivers. Slopes are plane and average about 0.5 percent. This soil is inundated once in every 2 to 5 years. Areas are long and narrow and parallel the rivers or are oval on bends of rivers.

The surface layer is reddish brown, calcareous, moderately alkaline fine sandy loam about 12 inches thick. Between depths of 12 and 36 inches is yellowish red, calcareous, moderately alkaline fine sandy loam. The underlying material, to a depth of 70 inches, is reddish yellow, calcareous, moderately alkaline fine sandy loam.

Surface runoff is slow. Permeability is moderately rapid, and available water capacity is medium. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Tilth is good, and the soil can be worked over a wide range of moisture conditions. The root zone is deep and is easily penetrated by plant roots.

Included with this soil in mapping are small areas of Clairemont and Lincoln soils. The Clairemont soils are in slightly lower areas, and the Lincoln soils are on slightly higher mounds. The included soils make up less than 20 percent of any area of this map unit.

This soil is used both as range and cropland. The potential is high for row crops and small grain. Crop residue left on the soil surface helps conserve moisture, slows the rate of runoff, reduces soil temperature, and maintains tilth and productivity. The potential is high for native range plants. The potential plant community is a mixture of mid and tall grasses.

This soil has low potential for most urban uses. Flooding is the most limiting feature. The potential is medium for recreation uses. Flooding is a limiting feature. Capability subclass IIw nonirrigated and IIw irrigated; Loamy Bottomland range site.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, rangeland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities; and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this

soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

The major management concerns when using the soils for crops and pasture are described in this section. In addition, the crops that are best adapted to Knox County are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and yields of the main crops are predicted for each soil.

This section provides information about overall agricultural potential and needed practices in the survey area for those in the agribusiness sector—equipment dealers, terracing and irrigation contractors, fertilizer companies, planners, conservationists, and others. Information about management of each kind of soil is presented in the section "Soil maps for detailed planning." When planning management systems for individual fields or farms, check the description of each soil present.

In Knox County, about 218,427 acres is cropland and pasture. Of this, 64,962 acres is irrigated cropland and 2,813 acres is in irrigated Coastal bermudagrass. Since 1965, 22,888 acres has been converted from dryland cropland to irrigated cropland and about 4,000 acres has been converted from range to dryland cropland. About 1,000 acres has been converted from irrigated cropland to irrigated Coastal bermudagrass pastures. The areas that have been converted to pasture were mostly marginal cropland and are better suited to pasture.

Field crops suited to the area and most commonly grown by dryland farming are cotton, grain sorghum, wheat, and guar. The most common irrigated crops are cotton, grain sorghum, and wheat. There is a small acreage in potatoes, watermelons, and cantaloups.

Soil fertility is naturally high in most of the soils in the county. Nitrogen and phosphorus are the only elements that are deficient in these soils and are added as commercial fertilizer for most cultivated crops. For wheat, nitrogen and phosphorus are applied at planting time, and nitrogen is also applied as top dressing late in winter. For most row crops, nitrogen and phosphorus are applied late in winter or early in spring.

Water erosion is a minor problem in the survey area. Most of the gently sloping areas in which row crops are grown have been terraced, and contour tillage is practiced. Gently sloping areas that are not terraced are planted to wheat. Crop residue left on the surface slows runoff and helps prevent erosion. The gently sloping areas of Aspermont, Enterprise, Hardeman, Miles, Tillman, Weymouth Variant, and Wichita soils are subject to water erosion. Terraces and diversions reduce the length of slope, slow runoff, and help prevent erosion.

Soil blowing is a major problem on Altus, Hardeman, Miles, Springer, and Winters soils. A cropping system that maintains a vegetative cover or keeps crop residue on the surface for extended periods reduces soil blowing to a minimum and maintains soil tilth and productivity.

Irrigation in the county is mostly south of the Brazos River. The main irrigated crops are cotton, grain sorghum, and wheat. Potatoes, watermelons, and cantaloups are also grown. There are also small irrigated Coastal bermudagrass pastures.

The nearly level soils that dominate this area are well suited to graded furrow irrigation, which is the method most commonly used. Sprinkler systems are used in areas that have complex slopes, in more sandy areas, and on irrigated pastures.

The main practices needed on soils that are used for irrigation are a suitable cropping system, good management of crop residue, adequate fertilization, proper management of water, and measures for controlling soil blowing and water erosion.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 4. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the soil is not suited to the crop or the crop is not commonly grown on the soil or that a given crop is not commonly irrigated.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. A few farmers may be obtaining average yields higher than those shown in table 4.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown; that good quality irrigation water is uniformly applied in proper amounts as needed; and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed.

The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 4 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at two levels: capability class and subclass. These levels are defined in the following paragraphs. A survey area may not have soils of all classes.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production. There are no class VIII soils in Knox County.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is indicated in table 5 which can be used to determine the farming potential of the soils. The capability class or subclass is identified in the description of each soil map unit in the section "Soil maps for detailed planning."

Range

About 58 percent of Knox County is range. There are 31 ranches in the county from 1,000 to 32,000 acres in size. Most ranches are about 2,000 acres.

Cow-calf operation is the main type of ranching in the county. Calves are usually marketed at weaning time or shortly thereafter. A few ranchers supplement range production with small grain grazing during winter.

The native vegetation in many parts of the survey area has been heavily grazed for several generations. As a result, the range has become infested with mesquite trees and lotebush in the upland areas and mesquite trees and saltcedar on the alluvial soils. Even though most of the range has been heavily grazed, a few sites produce a combination of grasses similar to the original potential plant community.

Where climate and topography are about the same, differences in the kind and amount of vegetation that rangeland can produce are related closely to the kind of soil. Effective management is based on the relationships among soils, vegetation, and water.

Table 6 shows, for each kind of soil, the name of the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the expected percentage of each species in the composition of the potential natural plant community. Soils not listed cannot support a natural plant community of predominately grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. The following are explanations of column headings in table 6.

A *range site* is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. Soils that produce a similar kind, amount, and proportion of range plants are grouped into range sites. For those areas where the relationship between soils and vegetation has been established, range sites can be interpreted directly

from the soil map. Properties that determine the capacity of the soil to supply moisture and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production refers to the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year the amount and distribution of precipitation and the temperatures are such that growing conditions are substantially better than average; in a normal year these conditions are about average for the area; in an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight refers to the total air-dry vegetation produced per acre each year by the potential natural plant community. Vegetation that is highly palatable to livestock and vegetation that is unpalatable are included. Some of the vegetation can also be grazed extensively by wildlife.

Characteristic species of grasses, grasslike plants, forbs, and shrubs that make up most of the potential natural plant community on each soil are listed by common name. Under *Composition*, the expected proportion of each species is presented as the percentage, in air-dry weight, of the total annual production of herbaceous and woody plants. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Generally all of the vegetation produced is not used.

Range management requires, in addition to knowledge of the kinds of soil and the potential natural plant community, an evaluation of the present condition of the range vegetation in relation to its potential. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the maximum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational areas; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by

personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 7 shows, for each kind of soil, the degree and kind of limitations for building site development; table 8, for sanitary facilities; and table 10, for water management. Table 9 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 7. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 7 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the compressibility and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 7 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 8 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, and *poor*, which mean about the same as the terms *slight*, *moderate*, and *severe*.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 8 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

If it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 9 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction material. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 13 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as

moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor.*

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 9 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 13.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can restrict plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils or very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 10 the degree of soil limitation and soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Soil and site limitations are expressed as slight, moderate, and severe. *Slight* means that the soil properties and site features are generally favorable for the specified use and that any limitation is minor and easily overcome. *Moderate* means that some soil properties or site features are unfavorable for the specified use but can be overcome or modified by special planning and design. *Severe* means that the soil properties and site features are so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance is required.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of the soil for use in embankments, dikes, and levees.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Parallel terraces with partially closed ends are the dominant system of terracing installed in recent years. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

The soils of the survey area are rated in table 11 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of

the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 11 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 8, and interpretations for dwellings without basements and for local roads and streets, given in table 7.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Wildlife habitat

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 12, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of habitat are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of

grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are lovegrass, various panicum species, plains bristlegrass, Texas wintergrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, broomweed, beggarweed, wheatgrass, ragweed, annual forbs, and grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture. Examples of shrubs, are lotebush, bumelia, tasajillo, littleleaf sumac, and wolfberry.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, dove, meadowlark, cottontail rabbit, and killdeer.

Rangeland habitat consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include antelope, white-tailed deer, jackrabbit, bobwhite quail, cottontail rabbit, dove, and meadowlark.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features, engineering test data, and data obtained from physical and chemical laboratory analyses of soils.

Engineering properties

Table 13 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 13 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 13 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 15. The estimated classification, without group index numbers, is given in table 13. Also in table 13 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Ranges in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

Physical and chemical properties

Table 14 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems. It is expressed as inches of water per inch of soil.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The

soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Engineering test data

Table 15 contains the results of engineering tests performed by the Texas Highway Department on some of the soils in Knox County. The table shows the specific location where samples were taken, the depth to which sampling was done, and the results of tests to determine particle-size distribution and other properties significant in soil engineering.

As moisture is removed, the soil shrinks and decreases in volume in direct proportion to the loss in moisture until a condition of equilibrium, called the *shrinking limit,* is reached. At this point shrinkage stops, although additional moisture is removed. Shrinkage limit is reported as the percentage of moisture in ovendry soil.

Linear shrinkage is the decrease in one dimension of the soil mass that occurs when the moisture content is reduced from the liquid limit to the shrinkage limit. It is expressed as a percentage of the original dimension.

Shrinkage ratio is the volume change that results from the drying of soil material divided by the moisture loss caused by drying. It is expressed numerically.

Mechanical analysis shows the percentages, by weight, of soil particles that pass sieves of specified sizes. Sand and other coarse materials do not pass the No. 200 sieve, as do the finer silt and clay particles.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistency of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from solid to plastic. If the moisture content is further increased, the material changes from plastic to liquid. The plastic limit is the moisture content at which the soil material passes from solid to plastic. The liquid limit is the moisture content at which the material changes from plastic to liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic.

Classification of the soils in the AASHTO and Unified systems of classification are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits.

Soil and water features

Table 16 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a

layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams or with runoff from adjacent slopes. Water standing for short periods after rains or after snow melts is not considered flooding. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding; and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*3*). Unless otherwise noted, colors described are for dry soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or map units, of each soil series are described in the section "Soil maps for detailed planning."

Altus series

The Altus series consists of dark brown soils that formed in loamy and sandy old alluvium. Slopes range from 0 to 1 percent.

Typical pedon of Altus fine sandy loam, 0 to 1 percent slopes; from the intersection of Texas Highway 283 and Texas Highway 222 in Knox City, 3.4 miles north on Texas Highway 283, then 200 feet east of highway right-of-way in a cultivated field:

Ap—0 to 10 inches; dark brown (7.5YR 4/2) fine sandy loam; dark brown (7.5YR 3/2) moist; weak fine subangular blocky structure; slightly hard, very friable; few fine roots; neutral; abrupt smooth boundary.

A1—10 to 18 inches; dark brown (7.5YR 4/2) fine sandy loam, dark brown (7.5YR 3/2) moist; weak medium subangular blocky structure; slightly hard, very friable; many fine pores; common worm casts; neutral; clear smooth boundary.

B21t—18 to 29 inches; reddish brown (5YR 4/3) sandy clay loam, dark reddish brown (5YR 3/3) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky; many fine and medium pores; thin patchy clay films on ped faces; mildly alkaline; clear smooth boundary.

B22t—29 to 47 inches; reddish brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky; many fine and medium pores; moderately alkaline; gradual smooth boundary.

B3—47 to 62 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, very friable; calcareous; moderately alkaline; gradual smooth boundary.

C—62 to 80 inches; yellowish red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; massive; slightly hard, very friable; few films and soft bodies of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 42 to 80 inches in thickness. The A horizon is dark brown, grayish brown, dark grayish brown, very dark grayish brown, or dark reddish gray.

The B21t horizon is reddish brown, dark brown, or dark grayish brown. Reaction is neutral or mildly alkaline. The B22t horizon is reddish brown, dark brown, very dark grayish brown, or yellowish red. Reaction ranges from neutral to moderately alkaline. The B3 horizon is reddish brown, reddish yellow, brown, or pale brown. Reaction ranges from neutral to moderately alkaline.

The C horizon is yellowish red, light reddish brown, dark brown, or pink. It is fine sandy loam or sandy clay loam.

Aspermont series

The Aspermont series consists of yellowish red soils that formed in calcareous loamy alluvial-colluvial material overlying silty red beds. Slopes range from 1 to 12 percent.

Typical pedon of Aspermont silty clay loam, 3 to 5 percent slopes; from the courthouse in Benjamin, 5.0 miles east on U.S. Highway 82, then 0.5 mile south in a cultivated field:

Ap—0 to 7 inches; yellowish red (5YR 5/6) silty clay loam, yellowish red (5YR 4/6) moist; weak fine subangular blocky structure; hard, friable, sticky; calcareous; moderately alkaline; clear smooth boundary.

B21—7 to 15 inches; yellowish red (5YR 5/6) silty clay loam, yellowish red (5YR 4/6) moist; moderate fine subangular blocky structure; hard, friable; few fine and very fine calcium carbonate concretions; calcareous; moderately alkaline; clear smooth boundary.

B22ca—15 to 36 inches; reddish yellow (5YR 6/6) silty clay loam, yellowish red (5YR 5/6) moist; moderate fine subangular blocky structure; hard, friable, sticky; 17 percent by volume concretions and soft bodies of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

C—36 to 60 inches; reddish yellow (5YR 6/6) silty clay loam, yellowish red (5YR 5/6) moist; massive; hard, very friable, sticky; common fine concretions and soft bodies of calcium carbonate; calcareous; moderately alkaline.

The solum is more than 60 inches thick. Depth to a distinct layer of calcium carbonate accumulation ranges from 12 to 20 inches. The A horizon is reddish brown, light brown, or yellowish red.

The B21 horizon is reddish brown or yellowish red. The B22ca horizon is reddish yellow, yellowish red, or red. Accumulations of calcium carbonate range from 5 to 30 percent by volume.

The C horizon is red, yellowish red, or reddish yellow. It is silty clay loam, fine sandy loam, or shaly clay.

Clairemont series

The Clairemont series consists of red soils that formed in recent alluvium on flood plains of streams. Slopes range from 0 to 1 percent.

Typical pedon of Clairemont silt loam, frequently flooded; from Vera, 1.0 mile north, 0.4 mile west, 2.4 miles north on county road, and 20 feet west in range; 0.13 mile south of the South Wichita River bridge:

A1—0 to 12 inches; red (2.5YR 4/6) silt loam, dark red (2.5YR 3/6) moist; weak fine subangular blocky structure; hard, very friable, sticky; many fine roots; many pores; calcareous; moderately alkaline; clear smooth boundary.

C1—12 to 36 inches; red (2.5YR 5/6) silty clay loam, red (2.5YR 4/6) moist; massive; hard, very friable, sticky; many fine roots; few pores; many thin strata of silt loam, loam, and fine sandy loam; calcareous; moderately alkaline; clear smooth boundary.

C2—36 to 42 inches; reddish brown (2.5YR 4/4) silty clay loam; dark reddish brown (2.5YR 3/4) moist; massive; hard, very friable, sticky; few thin strata of silt loam; few very fine calcium carbonate concretions; calcareous; moderately alkaline; clear smooth boundary.

C3—42 to 56 inches; light red (2.5YR 6/6) silt clay loam, red (2.5YR 5/6) moist; massive; hard, very friable, sticky; many thin strata of silt loam and loam; few very fine calcium carbonate concretions; calcareous; moderately alkaline; clear smooth boundary.

C4—56 to 80 inches; reddish brown (2.5YR 4/4) silty clay loam, dark reddish brown (2.5YR 3/4) moist; massive; hard, very friable, sticky; many thin strata of silt loam and loam; few fine calcium carbonate concretions; calcareous; moderately alkaline.

The A horizon is reddish brown or red. The C horizon is red, reddish brown, light reddish brown, light red, or reddish yellow. It is silty clay loam or loam and is stratified with layers of coarser and finer material.

Cobb series

The Cobb series consists of reddish brown soils that formed in material derived from medium grained Triassic and Permian sandstone. Slopes range from 0 to 3 percent.

Typical pedon of Cobb fine sandy loam, 1 to 3 percent slopes; from the courthouse in Benjamin, 2.8 miles west on U.S. Highway 82, 2.6 miles southwest on gravel road, 2.7 miles northwest and west on private road, and 30 feet south in cultivated field:

Ap—0 to 6 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak fine subangular blocky structure; hard, friable; neutral; abrupt smooth boundary.

B21t—6 to 24 inches; reddish brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) moist; moderate medium subangular blocky structure; hard, friable, sticky; common thin clay films; neutral; clear smooth boundary.

B22t—24 to 34 inches; reddish brown (2.5YR 4/4) sandy clay loam; dark reddish brown (2.5YR 3/4) moist; moderate medium subangular blocky structure; hard, friable, sticky; common thin clay films; neutral; abrupt smooth boundary.

Cr—34 to 40 inches; red weakly cemented sandstone.

The solum ranges from 20 to 40 inches in thickness. The A horizon is reddish brown or light reddish brown.

The B2t horizon is reddish brown or red. Reaction is neutral or mildly alkaline.

The Cr horizon is red, reddish brown, or grayish brown weakly to strongly cemented sandstone.

Cosh series

The Cosh series consists of reddish brown soils that formed in material derived from medium grained Triassic and Permian sandstone. Slopes range from 1 to 5 percent.

Typical pedon of Cosh fine sandy loam, 1 to 5 percent slopes; from Truscott, 3.1 miles west on Farm Road 1756, 500 feet west on private road, then 75 feet north in range:

A1—0 to 6 inches; reddish brown (2.5YR 4/4) fine sandy loam, dark reddish brown (2.5YR 3/4) moist; weak fine subangular blocky structure; slightly hard, very friable; many fine roots; mildly alkaline; abrupt smooth boundary.

B2t—6 to 18 inches; reddish brown (2.5YR 4/4) sandy clay loam, dark reddish brown (2.5YR 3/4) moist; moderate fine subangular blocky structure; hard, very friable, sticky; many fine roots; common thin clay films; mildly alkaline; abrupt smooth boundary.

Cr—18 to 24 inches; red (2.5YR 5/6) weakly cemented sandstone.

The solum is 12 to 20 inches thick. The A horizon is reddish brown to brown. Reaction is neutral or mildly alkaline.

The B2t horizon is reddish brown, weak red, or red. Reaction is neutral or mildly alkaline.

The Cr horizon is red, reddish brown, or grayish brown weakly to strongly cemented sandstone.

Cottonwood series

The Cottonwood series consists of reddish brown soils that formed in impure gypsum beds, mainly of the Blaine geologic formation. Slopes range from 5 to 16 percent.

Typical pedon of Cottonwood clay loam, in an area of Cottonwood-Knoco association, rolling; from Truscott, 5.6 miles west on Farm Road 1756 and private road, 1.8 miles south and southwest, then 0.25 mile north in range:

A1—0 to 8 inches; reddish brown (5YR 5/3) clay loam, reddish brown (5YR 4/3) moist; moderate fine subangular blocky and fine granular structure; hard, friable, sticky; common fine roots; common fine gypsum crystals; calcareous; moderately alkaline; abrupt boundary.

Cr—8 to 24 inches; white calcareous weakly cemented gypsum.

The solum ranges from 3 to 12 inches in thickness.

The A horizon is reddish brown, brown, grayish brown, light reddish brown, light brown, pinkish gray, or light brownish gray. It is loam or clay loam. It has 5 to 30 percent calcium carbonate concretions and soft bodies of gypsum.

The Cr horizon is gypsum or is gypsum interbedded with shaly clay.

Enterprise series

The Enterprise series consists of reddish brown soils that formed in medium textured eolian material that was blown from channels of nearby streams. Slopes range from 0 to 3 percent.

Typical pedon of Enterprise very fine sandy loam, 0 to 1 percent slopes; from the intersection of Farm Road 143 and Texas Highway 283 in Knox City, 5.1 miles west on Farm Road 143, then 75 feet north of road right-of-way in a cultivated field:

Ap—0 to 6 inches; reddish brown (5YR 5/4) very fine sandy loam, reddish brown (5YR 4/4) moist; weak fine subangular blocky structure; hard, very friable; mildly alkaline; abrupt smooth boundary.

A1—6 to 16 inches; reddish brown (5YR 5/4) very fine sandy loam, reddish brown (5YR 4/4) moist; weak fine subangular blocky structure; hard, very friable; mildly alkaline; clear smooth boundary.

B2—16 to 41 inches; yellowish red (5YR 5/6) very fine sandy loam, yellowish red (5YR 4/6) moist; weak fine subangular blocky structure; hard, very friable; few films and threads of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

C—41 to 72 inches; reddish brown (5YR 5/4) very fine sandy loam, reddish brown (5YR 4/4) moist; massive; hard, very friable; few films and threads of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 40 to 60 inches in thickness. Depth to carbonates is 0 to 20 inches.

The A horizon is reddish brown or light reddish brown. Reaction is mildly alkaline or moderately alkaline.

The B horizon is reddish brown, yellowish red, or reddish yellow. It is very fine sandy loam or loam.

The C horizon is reddish brown, yellowish red, or reddish yellow.

Hardeman series

The Hardeman series consists of reddish brown soils that formed in moderately coarse textured eolian material that was blown from the channels of nearby streams. Slopes range from 0 to 12 percent.

Typical pedon of Hardeman fine sandy loam, 5 to 12 percent slopes; from the intersection of Texas Highway 222 and Texas Highway 283 in Knox City, 1.8 miles north on Texas Highway 283, 3.0 miles west on Farm Road 1292, 0.3 mile north on county road, 0.75 mile west, 0.3 mile north on field road, then 50 feet east in range:

A1—0 to 13 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable; many fine roots; calcareous; moderately alkaline; gradual smooth boundary.

B2—13 to 42 inches; yellowish red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; weak fine subangular blocky structure; soft, very friable; many fine roots; few films and threads of calcium carbonate in the lower part; calcareous; moderately alkaline; gradual smooth boundary.

C—42 to 60 inches; reddish yellow (5YR 6/6) fine sandy loam, yellowish red (5YR 5/6) moist; massive; soft, very friable; few films and threads of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 35 to 50 inches in thickness.

The A horizon is reddish brown or brown. Reaction is mildly alkaline or moderately alkaline.

The B horizon is reddish brown, yellowish red, light reddish brown, light brown, reddish yellow, or red. It is fine sandy loam or loam.

The C horizon is yellowish red or reddish yellow.

Hollister series

The Hollister series consists of dark brown soils that formed in calcareous clay, mainly of the Permian age. Slopes range from 0 to 1 percent.

Typical pedon of Hollister clay loam, 0 to 1 percent slopes; from the intersection of Texas Highway 283 and Texas Highway 222 in Knox City, 9.2 miles north on Texas Highway 283, 1.2 miles east, 0.7 mile north, 0.2 mile west on private road, then 10 feet south of road in cultivated field:

A1—0 to 6 inches; dark brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; moderate fine and medium subangular blocky structure; hard, friable, sticky; common fine roots; moderately alkaline; abrupt smooth boundary.

B21t—6 to 15 inches; dark brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; common fine roots; very thin clay films; calcareous; moderately alkaline; gradual smooth boundary.

B22t—15 to 37 inches; dark brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) moist; moderate medium and coarse blocky structure; extreme-

ly hard, extremely firm, very sticky and very plastic; distinct continuous clay films; common slickensides; some peds tilted 10 to 15 degrees from the horizontal; calcareous; moderately alkaline; gradual smooth boundary.

B23tca—37 to 62 inches; dark brown (7.5YR 4/4) clay, dark brown (7.5YR 3/4) moist; moderate medium and coarse blocky structure; extremely hard, extremely firm, very sticky and very plastic; distinct continuous clay films; common slickensides; some peds tilted 10 to 15 degrees from the horizontal; few very fine calcium carbonate concretions; calcareous; moderately alkaline; gradual smooth boundary.

B24tca—62 to 80 inches; red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; moderate medium blocky structure; extremely hard, extremely firm, very sticky and very plastic; about 20 percent by volume soft bodies and concretions of calcium carbonate; calcareous; moderately alkaline.

The solum is more than 60 inches thick. The A horizon is dark brown, dark grayish brown, or grayish brown.

The B21t and B22t horizons are dark brown, dark grayish brown, or very dark grayish brown. The B23tca horizon is dark brown, brown, or yellowish red. The B24tca horizon is yellowish red, reddish brown, or red. Accumulations of calcium carbonate range from 1 to 20 percent by volume.

Knoco series

The Knoco series consists of red soils that formed in material derived from clayey Permian and Triassic red bed shales. Slopes range from 1 to 16 percent.

Typical pedon of Knoco clay, in an area of Knoco-Badland association, undulating; from intersection of Texas Highway 283 and Texas Highway 222 in Knox City, 7.4 miles north on Texas Highway 283, 0.25 mile east on private road, 150 feet on ranch road, then 50 feet west in range:

A1—0 to 8 inches; red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; moderate fine and medium blocky structure; very hard, firm, very sticky and very plastic; common fine roots; common fine pores; calcareous; moderately alkaline; clear smooth boundary.

Cr—8 to 60 inches; red (10R 4/6) clayey shale, dark red (10R 3/6) moist; massive; extremely hard, extremely firm; few roots in crevices of shale; few bodies and soft crystals of gypsum in upper 4 inches; calcareous; moderately alkaline.

Thickness of the solum to red bed shale ranges from 3 to 12 inches. Content of coarse fragments in the solum ranges from 0 to 15 percent by volume.

The A horizon is red, reddish brown, or yellowish red. It is clay or silty clay.

The Cr horizon is red or reddish brown clayey shale.

Lincoln series

The Lincoln series consists of yellowish red soils that formed in recent alluvium. Slopes range from 0 to 1 percent.

Typical pedon of Lincoln fine sand, frequently flooded; from the intersection of Texas Highway 283 and Texas Highway 222 in Knox City, 7.4 miles north on Texas Highway 283, 1.1 miles east, 0.75 mile southwest, 0.4 mile east, 0.2 mile south, 0.75 mile west on private road, then 0.3 mile south in range:

A1—0 to 8 inches; yellowish red (5YR 5/6) fine sand, yellowish red (5YR 4/6) moist; single grained; loose, very friable; common fine roots; calcareous; moderately alkaline; clear smooth boundary.

C1—8 to 50 inches; reddish yellow (5YR 6/6) fine sand, yellowish red (5YR 5/6) moist; single grained; loose; very friable; few strata of silt loam and fine sandy loam 1/2 to 1 inch thick; calcareous; moderately alkaline; clear smooth boundary.

C2—50 to 70 inches; yellowish red (5YR 5/6) loamy fine sand, yellowish red (5YR 4/6) moist; single grained; loose, very friable; few strata of fine sandy loam and fine sand 1/4 to 1 inch thick; calcareous; moderately alkaline.

The A horizon is yellowish red, reddish yellow, reddish brown, or light brown.

The C horizon is yellowish red, reddish yellow, or light brown. It is fine sand or loamy fine sand.

Mangum series

The Mangum series consists of reddish brown soils that formed in clayey sediment that was washed from soils that formed from the Permian red beds. Slopes are less than 1 percent.

Typical pedon of Mangum clay, frequently flooded; from the intersection of Texas Highway 283 and U.S. Highway 82 in Benjamin, 4.6 miles north on Texas Highway 283, then 300 feet east in range:

A1—0 to 10 inches; reddish brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; many fine roots; calcareous; moderately alkaline; clear smooth boundary.

C1—10 to 26 inches; reddish brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist; massive; extremely hard, extremely firm, very sticky and very plastic; common fine roots; cracks 1 inch wide extend to the bottom of this horizon; calcareous; moderately alkaline; clear smooth boundary.

C2—26 to 42 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; massive; extremely hard, extremely firm, very sticky and very plastic; few thin strata of silt loam; few fine roots; few fine calcium carbonate concretions; calcareous; moderately alkaline; clear smooth boundary.

C3—42 to 60 inches; reddish brown (2.5YR 5/4) clay, reddish brown (2.5YR 4/4) moist; massive; extremely hard, extremely firm, very sticky and very plastic; few very fine calcium carbonate concretions; calcareous; moderately alkaline.

The A horizon is reddish brown, red, or yellowish red.

The C horizon is reddish brown, red, or yellowish red. It is clay or silty clay.

Miles series

The Miles series consists of reddish brown soils that formed in old alluvium. Slopes range from 0 to 5 percent.

Typical pedon of Miles fine sandy loam, 0 to 1 percent slopes; from the intersection of Texas Highway 222 and U.S. Highway 277 in Munday, 4.2 miles west on Texas Highway 222 to Farm Road 1043, 0.2 mile west on Farm Road 1043, then 20 feet south of road right-of-way in a cultivated field:

Ap—0 to 10 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak fine subangular blocky structure; loose, very friable; neutral; abrupt smooth boundary.

B21t—10 to 27 inches; reddish brown (2.5YR 4/4) sandy clay loam, dark reddish brown (2.5YR 3/4) moist; moderate coarse prismatic structure parting to moderate fine subangular blocky; hard, friable, slightly sticky; many fine pores; common thin clay films; neutral; clear smooth boundary.

B22t—27 to 35 inches; red (2.5YR 4/6) sandy clay loam, dark red (2.5YR 3/6) moist; moderate coarse prismatic structure parting to moderate fine subangular blocky; hard, friable, slightly sticky; few fine pores; common very thin clay films; neutral; clear smooth boundary.

B23t—35 to 54 inches; red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) moist; moderate coarse prismatic structure parting to moderate fine subangular blocky; hard, friable, sticky; few fine pores; common thin clay films; mildly alkaline; clear smooth boundary.

B24t—54 to 70 inches; red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) moist; moderate coarse prismatic structure parting to moderate fine subangular blocky; hard, firm, sticky; few fine pores; few very thin clay films; few films and threads of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 60 to 80 inches in thickness.

The A horizon is reddish brown or brown. It is loamy fine sand or fine sandy loam. Reaction is neutral or mildly alkaline.

The Bt horizon is reddish brown or red. It is neutral or mildly alkaline in the upper part and becomes calcareous and moderately alkaline in the lower part in most pedons.

Owens series

The Owens series consists of reddish brown soils that formed in clayey material weathered from Permian shale. Slopes range from 5 to 16 percent.

Typical pedon of Owens clay, in an area of Vernon-Owens-Knoco association, rolling; from Vera, 1.05 miles north on county road, 0.5 mile west, 4.0 miles north and northwest, 0.15 mile south on ranch road, then 20 feet west in range:

A1—0 to 7 inches; reddish brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist; moderate fine subangular blocky structure; very hard, very firm, sticky and plastic; many fine roots; calcareous; moderately alkaline; clear smooth boundary.

B2ca—7 to 15 inches; reddish brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist; moderate medium blocky structure; extremely hard, extremely firm, very sticky and very plastic; few medium soft bodies of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

Cr—15 to 40 inches; reddish brown (2.5YR 5/4) clayey shale, reddish brown (2.5YR 4/4) moist; bluish gray strata; massive; very hard, very firm, sticky and plastic; calcareous, moderately alkaline.

The solum ranges from 10 to 20 inches in thickness.

The A horizon is reddish brown or weak red.

The B2ca horizon is reddish brown or weak red. Calcium carbonate accumulations range from a trace to about 10 percent, by volume.

The Cr horizon is reddish brown or red with bluish gray strata.

Randall series

The Randall series consists of dark gray soils that formed in clayey old alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Randall clay; from the Post Office in Gilliland, 1.2 miles north on county road, then 40 feet west in range:

A1—0 to 14 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate coarse blocky structure; extremely hard, extremely firm, very sticky and very plastic; calcareous; moderately alkaline; gradual wavy boundary.

AC1—14 to 37 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; coarse blocky structure; wedge shaped parallelepipeds tilted 20 degrees from the surface; many short intersecting slickensides; extremely hard, extremely firm, very sticky and very plastic; few fine calcium carbonate concretions; calcareous; moderately alkaline; gradual smooth boundary.

AC2—37 to 51 inches; gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; moderate coarse blocky structure; extremely hard, extremely firm, very sticky and very plastic; few very fine calcium carbonate concretions; calcareous; moderately alkaline; gradual wavy boundary.

AC3—51 to 70 inches; gray (10YR 6/1) clay, gray (10YR 5/1) moist; few fine faint to distinct pale olive and yellowish brown mottles; weak medium blocky structure; extremely hard, extremely firm, very sticky and very plastic; calcareous; moderately alkaline.

The solum ranges from 41 to 70 inches or more in thickness.

The A horizon is gray, dark gray, or very dark gray. The AC horizon is gray, dark gray, or grayish brown.

Rotan series

The Rotan series consists of dark grayish brown soils that formed in old alluvium. Slopes range from 0 to 1 percent.

Typical pedon of Rotan clay loam, 0 to 1 percent slopes; from the city hall in Munday, 3.1 miles south on U.S. Highway 277, 1.3 miles west on Farm Road 2365, then 100 feet south in a cultivated field:

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky and fine granular structure; hard, friable, sticky and plastic; mildly alkaline; abrupt smooth boundary.

B1—10 to 18 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, friable, sticky and plastic; mildly alkaline; clear smooth boundary.

B21t—18 to 24 inches; dark brown (10YR 4/3) clay, dark brown (10YR 3/3) moist; moderate medium blocky structure; very hard, firm, sticky and plastic; thin clay films; moderately alkaline; clear smooth boundary.

B22t—24 to 36 inches; dark brown (10YR 4/3) clay, dark brown (10YR 3/3) moist; moderate medium blocky structure; very hard, firm, sticky and plastic; thin clay films; few fine calcium carbonate concretions; calcareous; moderately alkaline; clear smooth boundary.

B23tca—36 to 62 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; moderate medium blocky structure; very hard, firm, sticky and plastic; 40 percent, by volume, soft bodies and concretions of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

B24tca—62 to 70 inches; yellowish red (5YR 5/6) clay, yellowish red (5YR 4/6) moist; few fine faint brown mottles; weak medium blocky structure; very hard, firm, sticky and plastic; 10 percent, by volume, soft bodies and concretions of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 60 to more than 80 inches in thickness. Carbonates are within 10 to 28 inches of the surface. The calcic horizon is within 30 to 60 inches of the surface.

The A horizon is dark grayish brown or dark brown. Reaction is mildly alkaline or moderately alkaline.

The Bt horizon above the calcic horizon is dark grayish brown, dark brown, or brown. It is clay loam in the upper part and clay in the lower part. Reaction is mildly alkaline or moderately alkaline. The Btca horizon is white, brown, yellowish red, or reddish yellow. Accumulations of calcium carbonate range from 10 to 50 percent, by volume.

Rowena series

The Rowena series consists of dark brown soils that formed in calcareous clay loam to clay sediments. Slopes range from 0 to 1 percent.

Typical pedon of Rowena clay loam, 0 to 1 percent slopes; from the intersection of U.S. Highway 277 and Farm Road 266 in Goree, 0.85 mile south and east along Farm Road 266, 1.4 miles east on county road, 0.75 mile south, then 400 feet west in a cultivated field:

Ap—0 to 8 inches; dark brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate fine subangular blocky and fine granular structure; hard, friable, sticky and plastic; calcareous; moderately alkaline; abrupt smooth boundary.

B21—8 to 24 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; few very fine calcium carbonate concretions; calcareous; moderately alkaline; gradual wavy boundary.

B22—24 to 32 inches; dark brown (10YR 4/3) clay, dark brown (10YR 3/3) moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; few very fine calcium carbonate concretions; calcareous; moderately alkaline; gradual wavy boundary.

B23ca—32 to 40 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; weak medium subangular blocky structure; very hard, very firm, sticky and plastic; 20 percent, by volume, soft bodies and concretions of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

C1ca—40 to 52 inches; yellowish red (5YR 5/6) clay, yellowish red (5YR 4/6) moist; massive; hard, firm, sticky and plastic; 40 percent, by volume, soft bodies and concretions of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

C2ca—52 to 70 inches; reddish yellow (5YR 6/6) clay, yellowish red (5YR 5/6) moist; massive; hard, firm, sticky and plastic; 15 percent, by volume, fine concretions of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 28 to 48 inches in thickness. The calcic horizon is 28 to 40 inches from the surface. The A, B21, and B22 horizons are brown, dark brown, or dark grayish brown.

The B2 horizon is clay or clay loam. The B23ca horizon is brown or reddish brown. Accumulations of calcium carbonate range from 15 to 40 percent, by volume.

The Cca horizon is brown, reddish yellow, or yellowish red. Accumulations of calcium carbonate range from 15 to 50 percent, by volume.

Sagerton series

The Sagerton series consists of dark brown soils that formed in clayey sediment several feet thick. Slopes range from 0 to 3 percent.

Typical pedon of Sagerton clay loam, 0 to 1 percent slopes; from the intersection of Texas Highway 267 and Texas Highway 222 west of Munday, 8.6 miles north on Texas Highway 267, then 50 feet east of road right-of-way in a cultivated field:

Ap—0 to 8 inches; dark brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; mildly alkaline; abrupt smooth boundary.

B21t—8 to 18 inches; reddish brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; few fine pores; common thin clay films; moderately alkaline; clear smooth boundary.

B22t—18 to 36 inches; red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; common thin clay films; few very fine concretions of calcium carbonate below 22 inches; calcareous; moderately alkaline; clear smooth boundary.

B23tca—36 to 60 inches; light red (2.5YR 6/6) clay, red (2.5YR 5/6) moist; moderate medium blocky structure; very hard, firm, sticky and plastic; 35 percent, by volume, soft bodies and concretions of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

B24tca—60 to 80 inches; light red (2.5YR 6/6) clay, red (2.5YR 5/6) moist; weak medium blocky structure; very hard, firm, sticky and plastic; 10 percent, by volume, soft bodies and concretions of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 60 to more than 80 inches in thickness. Depth to secondary carbonates ranges from 20 to 28 inches.

The A horizon is dark brown, reddish brown, or dark reddish gray. Reaction is neutral or mildly alkaline.

The B21t horizon is dark brown, reddish brown, or dark reddish gray. It is clay or clay loam. Reaction is mildly alkaline or moderately alkaline. The lower part of the B2t horizon above the calcic horizon is reddish brown or red. The B23tca horizon is reddish brown, red, light reddish brown, or light red. Accumulations of calcium carbonate range from 15 to 50 percent, by volume. The B24tca horizon is red, light red, or reddish brown. Accumulations of calcium carbonate range from 5 to 15 percent, by volume.

Springer series

The Springer series consists of brown soils that formed in unconsolidated sandy sediment of eolian or alluvial origin. Slopes range from 0 to 3 percent.

Typical pedon of Springer loamy fine sand, 0 to 3 percent slopes; from the intersection of Texas Highway 283 and Texas Highway 222 in Knox City, 3.75 miles north on Texas Highway 283, 0.7 mile west on Farm Road 1292, then 100 feet north in range:

A1—0 to 18 inches; brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; single grained; loose, very friable; many fine roots; mildly alkaline; clear smooth boundary.

B2t—18 to 31 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak fine to medium subangular blocky structure; slightly hard, very friable; sand grains bridged with clay; mildly alkaline; clear smooth boundary.

B3—31 to 50 inches; yellowish red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; weak fine subangular blocky structure; soft, very friable; mildly alkaline; clear smooth boundary.

A'2—50 to 68 inches; light reddish brown (5YR 6/4) loamy fine sand, reddish brown (5YR 5/4) moist; single grained; loose, very friable; mildly alkaline; clear smooth boundary.

B'2t—68 to 80 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable; sand grains bridged and coated with clay; moderately alkaline.

The solum ranges from 60 to more than 80 inches in thickness.

The A horizon is brown, light reddish brown, or reddish brown. Reaction is neutral or mildly alkaline.

The B2t and B3 horizons are reddish brown, reddish yellow, or yellowish red. Reaction is neutral or mildly alkaline.

The A'2 horizon is light brown, brown, light reddish brown, or yellowish red. Reaction is mildly alkaline or moderately alkaline.

The B'2t horizon is brown, reddish brown, or yellowish red. It is fine sandy loam or sandy clay loam. Reaction is mildly alkaline or moderately alkaline.

Tillman series

The Tillman series consists of reddish brown soils that formed in ancient alluvium that was washed from red bed shales and clays. Slopes range from 0 to 3 percent.

Typical pedon of Tillman clay loam, 0 to 1 percent slopes; from the courthouse in Benjamin, 1.3 miles east on

U.S. Highway 82, 0.4 mile south on county road, then 50 feet east in a cultivated field:

Ap—0 to 7 inches; reddish brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; moderate medium blocky structure; hard, firm, sticky and plastic; few fine roots; mildly alkaline; abrupt smooth boundary.

B21t—7 to 16 inches; reddish brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; few fine roots; common thin clay films; moderately alkaline; clear smooth boundary.

B22t—16 to 27 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; moderate medium blocky structure; extremely hard, extremely firm, very sticky and plastic; common thin clay films; few soft bodies of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

B23t—27 to 40 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate medium blocky structure; extremely hard, extremely firm, very sticky and very plastic; common thin clay films; few soft bodies and concretions of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

B24t—40 to 56 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate medium blocky structure; extremely hard, extremely firm, very sticky and plastic; few very fine concretions of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

B25tca—56 to 80 inches; yellowish red (5YR 5/6) clay; yellowish red (5YR 4/6) moist; moderate medium blocky structure; extremely hard, extremely firm, very sticky and very plastic; few soft bodies and common films and threads of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 60 to more than 80 inches in thickness. Secondary carbonates are within 12 to 24 inches of the surface.

The A horizon is reddish brown, dark reddish brown, brown, or dark brown. Reaction is mildly alkaline or moderately alkaline.

The B21t horizon is reddish brown, dark reddish brown, brown, or dark brown. Reaction is mildly alkaline or moderately alkaline. The B22t, B23t, and B24t horizons are reddish brown, dark red, or red. The B25tca horizon is yellowish red, red, or reddish brown. The Bt horizon is clay loam or clay. Accumulations of calcium carbonate range from 1 to 10 percent, by volume.

Tobosa series

The Tobosa series consists of dark grayish brown soils that formed in calcareous clays several feet thick. Slopes range from 0 to 1 percent.

Typical pedon of Tobosa clay, 0 to 1 percent slopes; from the Post Office in Gilliland, 2.0 miles south, 1.45 miles west on county road, then 200 feet south in a cultivated field:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate fine to medium subangular blocky structure; very hard, firm, sticky and plastic; calcareous; moderately alkaline; abrupt smooth boundary.

A11—8 to 24 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; calcareous; moderately alkaline; clear smooth boundary.

A12—24 to 45 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate medium blocky structure with parallelepipeds with long axis tilted 30 degrees from the horizontal; very hard, very firm, sticky and plastic; few very fine concretions of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

AC—45 to 60 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; few soft bodies and fine concretions of calcium carbonate; few gypsum crystals; calcareous; moderately alkaline; gradual wavy boundary.

C1ca—60 to 70 inches; light brown (7.5YR 6/4) clay, brown (7.5YR 5/4) moist; dark grayish brown streaks; massive; very hard, very firm, sticky and plastic; 20 to 30 percent, by volume, soft bodies and concretions of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

C2ca—70 to 80 inches; pink (7.5YR 7/4) clay, light brown (7.5YR 6/4) moist; massive; hard, firm, sticky and plastic; about 50 percent, by volume, soft bodies and concretions of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 40 to more than 80 inches in thickness.

The A horizon is dark grayish brown, grayish brown, or dark brown. The AC horizon is brown, grayish brown, or light brown.

The Cca horizon is pink, reddish yellow, light brown, or pale brown. Accumulations of calcium carbonate range from 10 to 50 percent, by volume.

Vernon series

The Vernon series consists of reddish brown soils that formed in clayey material weathered from shales and clays of Permian age. Slopes range from 1 to 16 percent.

Typical pedon of Vernon clay, 3 to 8 percent slopes; from the courthouse in Benjamin, 7.0 miles east on U.S. Highway 82, 1.7 miles north on Farm Road 267, then 10 feet east of road right-of-way in range:

A1—0 to 8 inches; reddish brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist; moderate fine subangular blocky structure; very hard, very firm, sticky and plastic; few fine concretions of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

B21—8 to 22 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate medium blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine concretions of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

B22—22 to 32 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; weak medium blocky structure; extremely hard, very firm, sticky and plastic; about 20 percent fine shale fragments; calcareous; moderately alkaline; clear smooth boundary.

Cr—32 to 60 inches; weak red (10R 4/4) clayey shale, weak red (10R 4/4) moist; massive; extremely hard, very firm, sticky and plastic; thin strata of olive and gray material; calcareous; moderately alkaline.

The solum ranges from 20 to 36 inches in thickness. The A horizon is reddish brown or red. The B2 horizon is reddish brown, red, or yellowish red. The Cr horizon is red, weak red, or reddish brown.

Weymouth Variant

The Weymouth Variant consists of reddish brown soils that formed in material weathered from clayey shales of Permian or Triassic age. Slopes range from 1 to 5 percent.

Typical pedon of Weymouth Variant clay loam, 1 to 3 percent slopes; from the intersection of Farm Road 1756 and Texas Highway 283 in Truscott, 9.0 miles west on Farm Road 1756 and private road, then 20 feet south in range:

A1—0 to 9 inches; reddish brown (2.5YR 4/4) clay loam, dark reddish brown (2.5YR 3/4) moist; moderate fine subangular blocky structure; hard, firm, sticky and plastic; calcareous; moderately alkaline; clear smooth boundary.

B2—9 to 20 inches; red (2.5YR 4/6) clay loam, dark red (2.5YR 3/6) moist; moderate medium blocky structure; hard, firm, sticky and plastic; calcareous; moderately alkaline; clear smooth boundary.
B2ca—20 to 32 inches; red (2.5YR 5/6) clay loam, red (2.5YR 4/6) moist; weak medium blocky structure; hard, firm, sticky; 15 percent, by volume, soft bodies and concretions of calcium carbonate; calcareous; moderately alkaline; abrupt smooth boundary.
R—32 to 40 inches; limestone bedrock.

The solum ranges from 20 to 36 inches in thickness. The A horizon is reddish brown or brown.

The B2 horizon is reddish brown, red, or brown. It is clay loam or loam. The B2ca horizon is reddish brown or red. It is clay loam or loam. Accumulations of calcium carbonate range from 1 to 15 percent, by volume.

Wichita series

The Wichita series consists of reddish brown soils that formed in ancient alluvium. Slopes range from 0 to 5 percent.

Typical pedon of Wichita clay loam, 0 to 1 percent slopes; from the intersection of Texas Highway 283 and Texas Highway 222 in Knox City, 9.0 miles north on Texas Highway 283, 0.3 mile east on gravel road, then 75 feet south in a cultivated field:

Ap—0 to 8 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; weak fine subangular blocky structure; hard, friable, sticky; few fine roots; few siliceous pebbles; mildly alkaline; abrupt smooth boundary.
B21t—8 to 17 inches; reddish brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; moderate medium blocky structure; hard, firm, sticky and plastic; common thin clay films; mildly alkaline; clear smooth boundary.
B22t—17 to 38 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate medium blocky structure; hard, firm, sticky and plastic; continuous thin clay films; few threads of calcium carbonate; few siliceous pebbles; calcareous; moderately alkaline; clear smooth boundary.
B23t—38 to 52 inches; red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; moderate medium blocky structure; extremely hard, very firm, sticky and plastic; continuous thin clay films; few very fine concretions of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.
B24tca—52 to 70 inches; red (2.5YR 5/6) clay, red (2.5YR 4/6) moist; weak medium blocky structure; very hard, firm, sticky and plastic; 10 percent, by volume, soft bodies and concretions of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 60 to about 80 inches in thickness.

The A horizon is brown or reddish brown. In pedons with moist value and chroma of less than 3.5, the thickness of the A horizon is less than 10 inches.

The B2t horizon is reddish brown or red. It is clay loam in the upper part and clay in the lower part. The B2tca horizon is red or reddish brown. Accumulations of calcium carbonate range from 3 to 15 percent, by volume.

Winters series

The Winters series consists of reddish brown soils that formed in old alluvium. Slopes range from 0 to 1 percent.

Typical pedon of Winters fine sandy loam, 0 to 1 percent slopes; from the intersection of Farm Road 267 and Texas Highway 222 west of Munday, 0.95 mile north on Farm Road 267, west 1.0 mile, then 200 feet south in a cultivated field:

Ap—0 to 10 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable; neutral; abrupt smooth boundary.
B21t—10 to 20 inches; reddish brown (2.5YR 4/4) sandy clay, dark reddish brown (2.5YR 3/4) moist; moderate medium blocky structure; very hard, firm, sticky and plastic; few very thin clay films; mildly alkaline; clear smooth boundary.
B22t—20 to 48 inches; red (2.5YR 5/6) sandy clay; red (2.5YR 4/6) moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; few very thin clay films; mildly alkaline; clear smooth boundary.
B23tca—48 to 70 inches; light red (2.5YR 6/6) sandy clay, red (2.5YR 5/6) moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; few patchy clay films; few fine concretions of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 60 to more than 80 inches in thickness.

The A horizon is brown or reddish brown.

The B2t horizon is reddish brown, red, or yellowish red. The B2tca horizon is light red, reddish brown, or reddish yellow. Accumulations of calcium carbonate range from 1 to 15 percent, by volume.

Yahola series

The Yahola series consists of reddish brown soils that formed in recent alluvium. Slopes range from 0 to 1 percent.

Typical pedon of Yahola fine sandy loam, in an area of Lincoln-Yahola complex, occasionally flooded; from the intersection of Farm Road 266 and U.S. Highway 277, 8.0 miles north on Farm Road 266, 20 feet east of road right-of-way in range:

A1—0 to 12 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable; many fine roots; calcareous; moderately alkaline; clear smooth boundary.
C1—12 to 36 inches; yellowish red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; massive; slightly hard, very friable; few thin strata of silt loam and very fine sandy loam; calcareous; moderately alkaline; clear smooth boundary.
C2—36 to 70 inches; reddish yellow (5YR 6/6) fine sandy loam, yellowish red (5YR 4/6) moist; massive; slightly hard, very friable; few thin strata of sand and gravel; calcareous; moderately alkaline.

The A horizon is reddish brown, reddish yellow, or yellowish red. The C horizon is reddish yellow, yellowish red, reddish brown, light reddish brown, or red.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*4*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 17, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol.* An example is Alfisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustalf (*Ust*, meaning burnt, plus *alf*, from Alfisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Paleustalfs (*Pale*, meaning old, plus *ustalf*, the suborder of Alfisols that have an ustic moisture regime).

SUBGROUP. Each great group may be divided into three kinds of subgroups: the central (typic) concept of the great group, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great group; and the extragrades, which have some properties that are representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Paleustalfs.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine, mixed, thermic Typic Paleustalfs.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition. The Wichita series is an example of a fine, mixed, thermic Typic Paleustalf.

Formation of the soils

In this section the factors that affect the formation of the soils in Knox County are discussed, and important processes in the differentiation of soil horizons are briefly described.

Factors of soil formation

Soil is the result of the interaction of the five major factors of soil formation: parent material, climate, plants and animals, relief, and time. If a factor, such as relief or vegetation, varies from place to place, different kinds of soil form.

Parent material

Parent material is the unconsolidated mass from which a soil forms. It determines the limits of chemical and mineral composition of the soil. Parent material of the soils of Knox county consists of red-bed shale, sandstone, gypsum, wind deposits, and alluvium.

Vernon and Owens soils are examples of soils that formed in material weathered from red-bed shale and marl of the Clear Fork Group of Lower Permian age. Cobb and Cosh soils formed in material weathered from San Angelo sandstone. Cottonwood soils formed in gypsum, mainly in the Blaine gypsum formation. Enterprise and Hardeman soils formed in wind deposits from the Brazos River. Miles, Rotan, and Rowena soils formed in old alluvium or plains outwash material. The alluvium deposited during Pleistocene and Recent ages overlies uneven, eroded areas of red beds. Clairemont and Yahola soils formed in more youthful alluvium along rivers and streams.

Climate

Knox County has a dry, subhumid climate that is characterized by rapid changes, marked extremes, and wide daily and annual variation in temperature. The climate is similar to that which existed when the soils formed. It is uniform throughout the county, and differences among the soils are not the result of climate effects.

Plants and animals

Plants, animals, insects, bacteria, and fungi are important in the formation of soils. They add to the supply of organic matter and nitrogen in the soil, cause gains or losses in plant nutrients, and change the structure and porosity of the soils. Plants, mainly short, mid, and tall grasses, have affected soil formation more than other organisms. The plants contributed to the accumulation of organic matter and thus to the darkening of the soils. Generally, soils that formed under grasses have a high content of organic matter. Examples of these are Sagerton, Rotan, and Rowena soils.

Relief

Relief influences soil formation through its effect on drainage, runoff, erosion, plant cover, and soil temperature. In Knox County much of the area is nearly level to gently sloping with slopes less than 3 percent. In some areas, however, steep breaks have slopes of as much as 30 percent.

On the steeper slopes where runoff is rapid, the soil material is likely to be removed by erosion almost as fast as horizons develop. Owens soils, for example, formed on stronger slopes than Tillman soils. Therefore, they are thinner, and their profile is not so well developed. Miles, Rotan, and Sagerton soils formed in nearly level to gently sloping areas. Much of the rain that falls does not run off these soils but is absorbed. The rainfall causes leaching and affects other soil-forming processes that aid in the formation of distinct soil horizons.

Time

Generally, a long time is required for formation of soils that have distinct horizons. The length of time that parent material has been in place is commonly reflected in the degree of development of the soil profile.

The soils in Knox County range from young to old. The young soils have had little profile development, but the older soils have well expressed horizons. Clairemont soils are examples of young soils; they have a weakly developed profile. Miles soils are examples of older, or mature, alluvial soils that show marked horizon differentiation. They have been in place for a long time and have reached equilibrium with their environment.

Processes of horizon differentiation

Several processes have been involved in the differentiation of soil horizons in Knox County. Among these are (1) accumulation of organic matter, (2) leaching of calcium carbonates and bases, (3) reduction and transfer of iron, and (4) formation and translocation of silicate clay minerals. In most soils more than one of these process have been active in the development of horizons.

Accumulation of organic matter in the upper part of the profile has been important in the formation of an A1 horizon.

Leaching of carbonates and bases is apparent in many of the soils. The leaching of bases in soils generally precedes translocation of silicate clay minerals. Most of the soils of Knox County are moderately leached, and this leaching contributed to the development of horizons.

Reduction and transfer of iron is evident in the poorly drained soils of the county. The gray color in the subsurface horizons indicates the reduction of iron.

In some of the soils, the translocation of clay minerals has contributed to horizon development. The eluviated A horizon above the B horizon in some of the more sandy soils is lower in clay content and generally is lighter in color than the B horizon. In most places the B horizon has an accumulation of clay (clay films) in pores and on the surfaces of peds. These soils were probably leached of carbonates and soluble salts before translocation of silicate clay took place. Leaching of bases and translocation of silicate clay are among the principal processes in horizon differentiation in the soils of Knox County. Miles soils are examples of soils that have clay films and bridges in the B horizon.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standards and specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. No. 18, 503 pp., illus. (Supplements replacing pp. 173-183 issued in May 1962)

(4) United States Department of Agriculture. 1975. Soil taxonomy: a basic system of soil classification for making and interpreting soil surveys. U.S. Dep. Agric. Handb. 436, 754 pp., illus.

Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single mapping unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Medium	6 to 9
High	More than 9

Badland. Steep or very steep, commonly nonstony barren land dissected by many intermittent drainage channels. Badland is most common in semiarid and arid regions where streams are entrenched in soft geologic material. Local relief generally ranges from 25 to 500 feet. Runoff potential is very high, and geologic erosion is active.

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change as long as the environment remains the same.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A map unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Compressible. Excessive decrease in volume of soft soil under load.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gypsum. Hydrous calcium sulphate.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the

solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. Inadequate strength for supporting loads.

Miscellaneous areas. Areas that have little or no natural soil, are too nearly inaccessible for orderly examination, or cannot otherwise be feasibly classified.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind and amount of native vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slow intake. The slow movement of water into the soil.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy*

(laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across slopes on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or " very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but the limited geographic soil area does not justify creation of a new series.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Illustrations

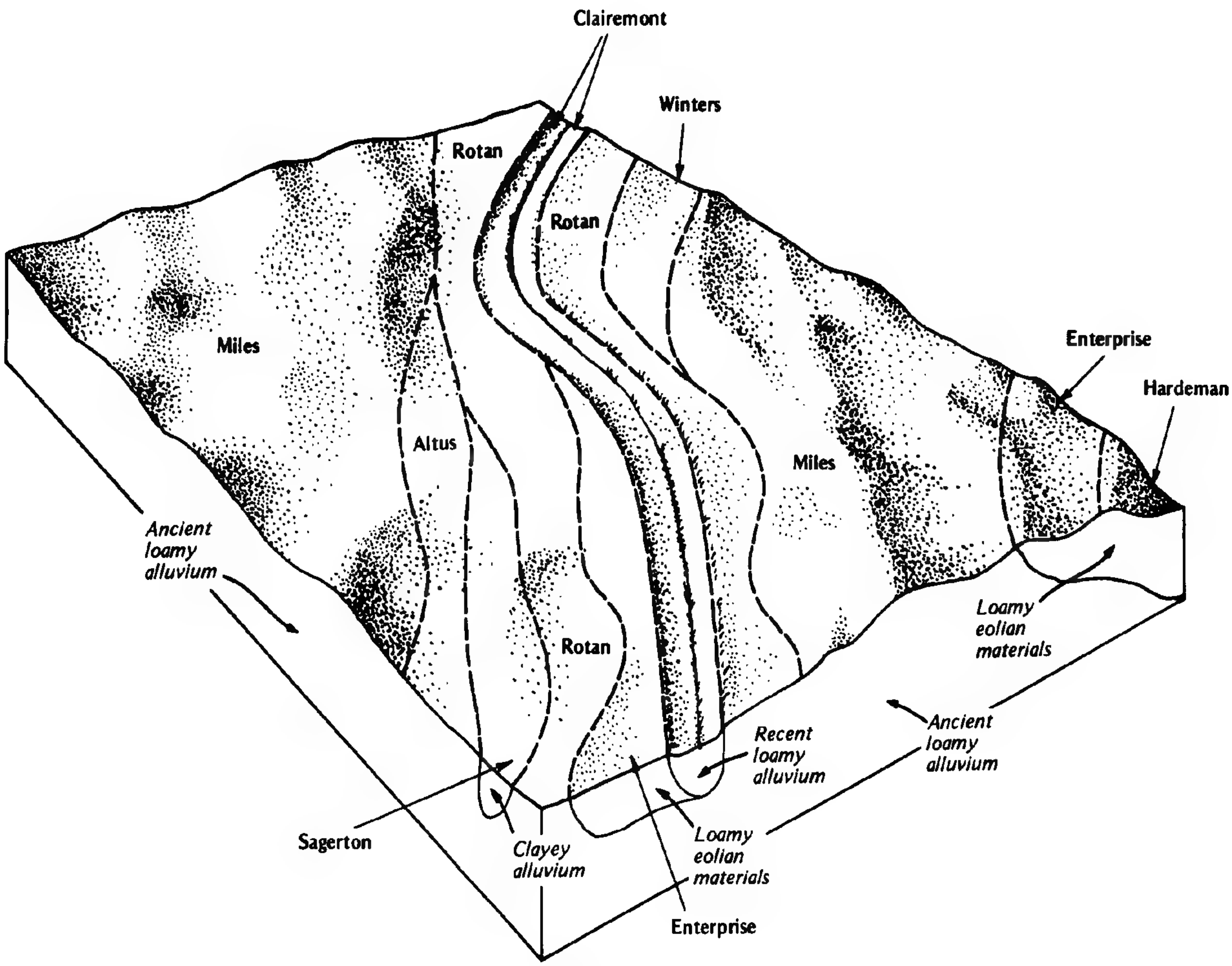

Figure 1.—Representative pattern of soils in Miles-Rotan map unit.

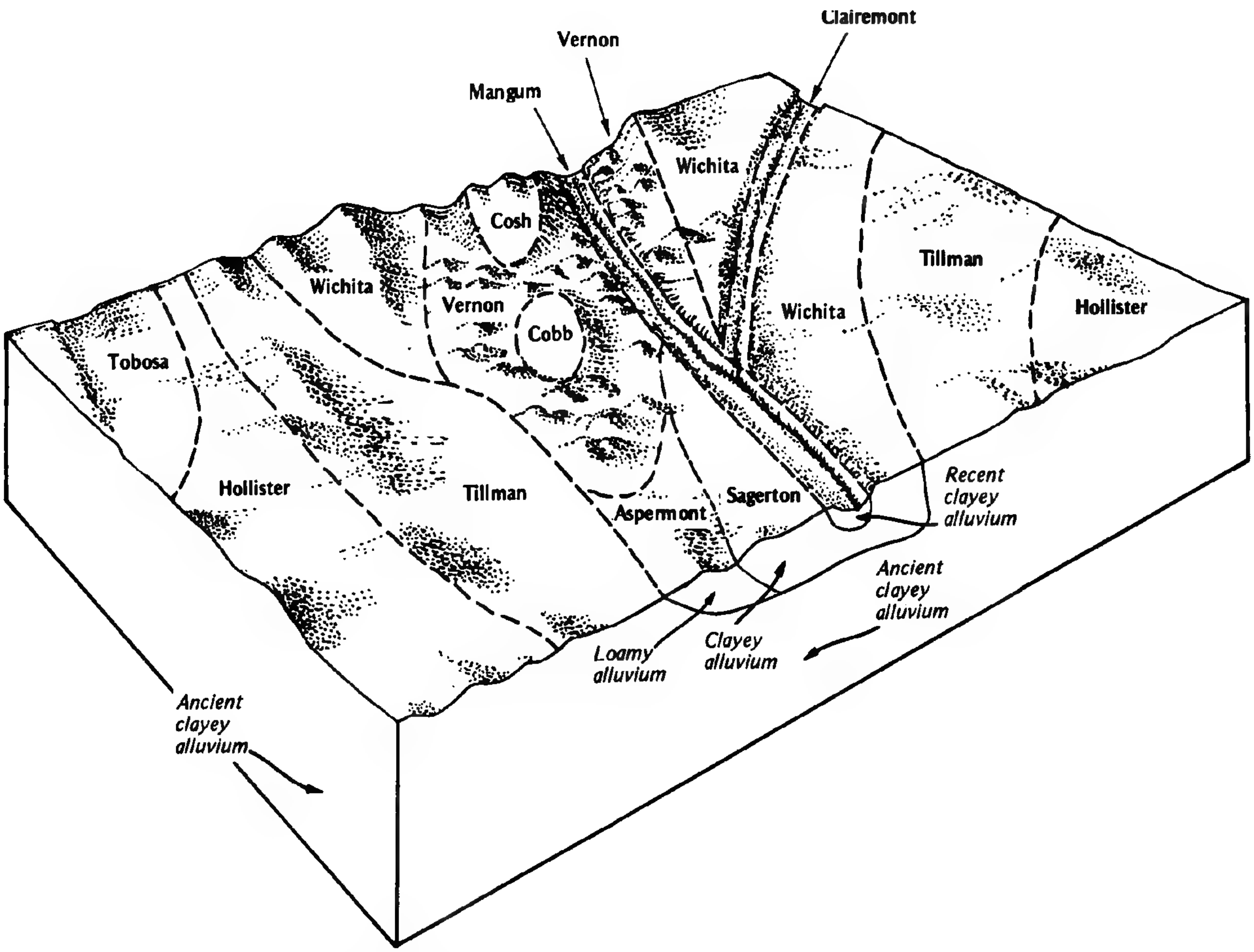

Figure 2.—Representative pattern of soils in Tillman-Hollister-Wichita map unit.

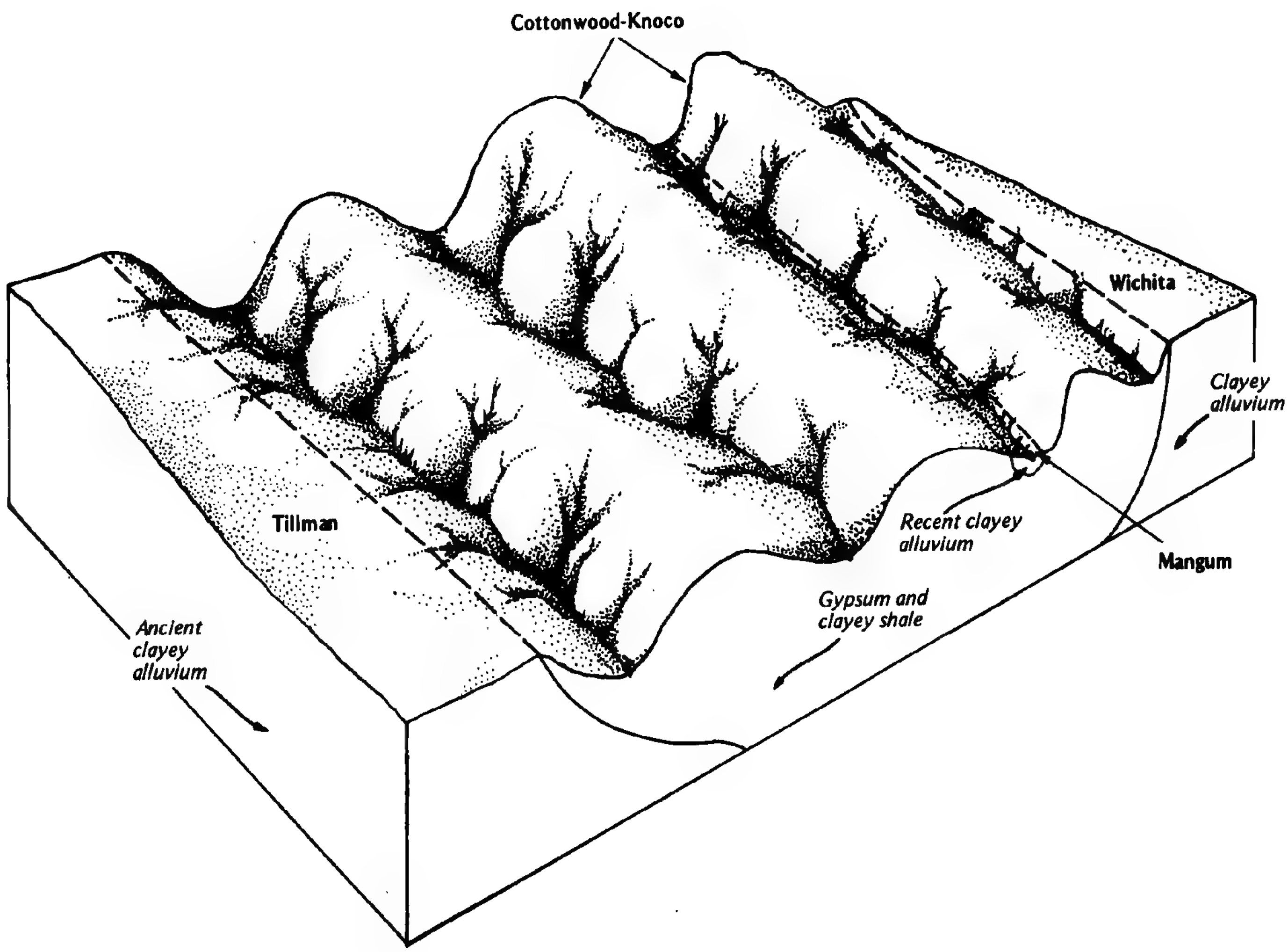

Figure 3.—Representative pattern of soils in Cottonwood-Knoco map unit.

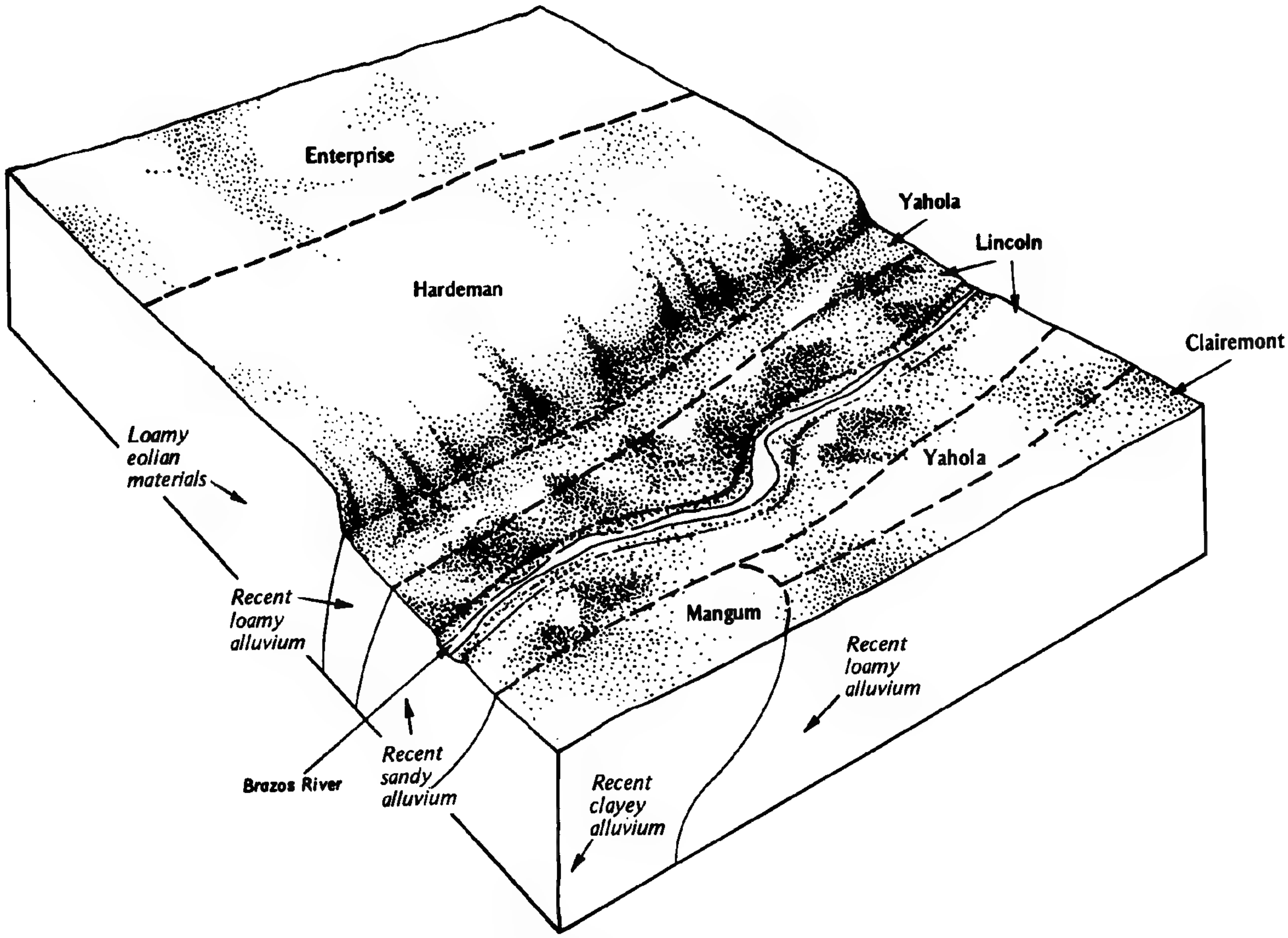

Figure 4.—Representative pattern of soils in Hardeman-Enterprise-Lincoln map unit.

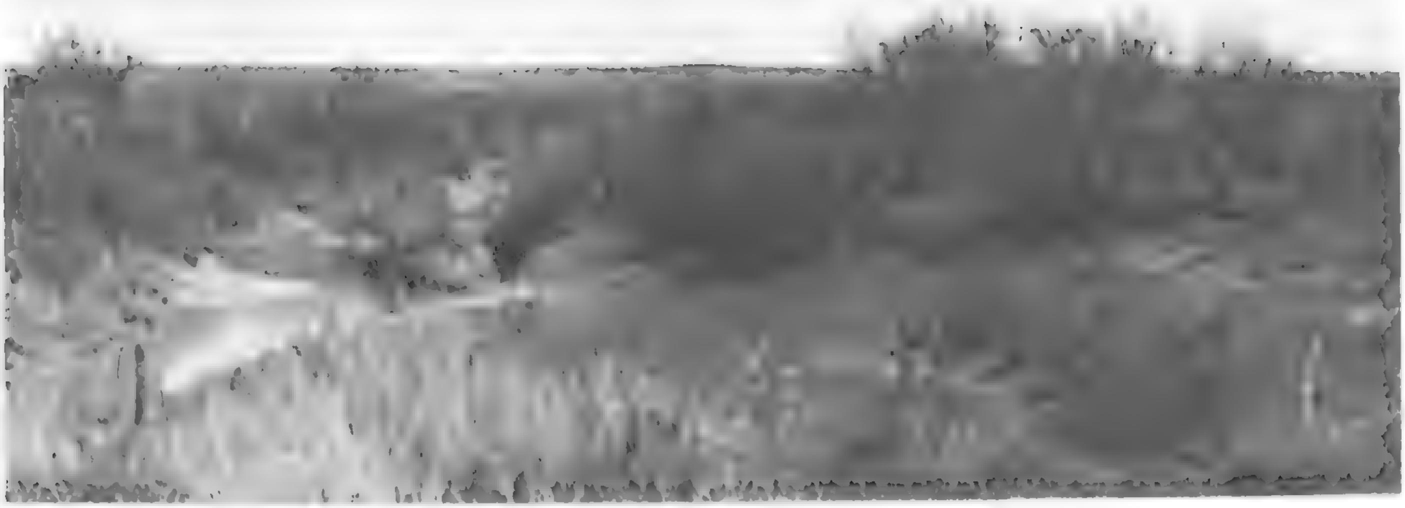

Figure 5.—Area of Clairemont silt loam, frequently flooded.

Figure 6.—Area of Cottonwood-Knoco association, rolling.

Figure 7.—Area of Hardeman fine sandy loam, 5 to 12 percent slopes.

Figure 8.—Area of Knoco-Badland association, undulating.

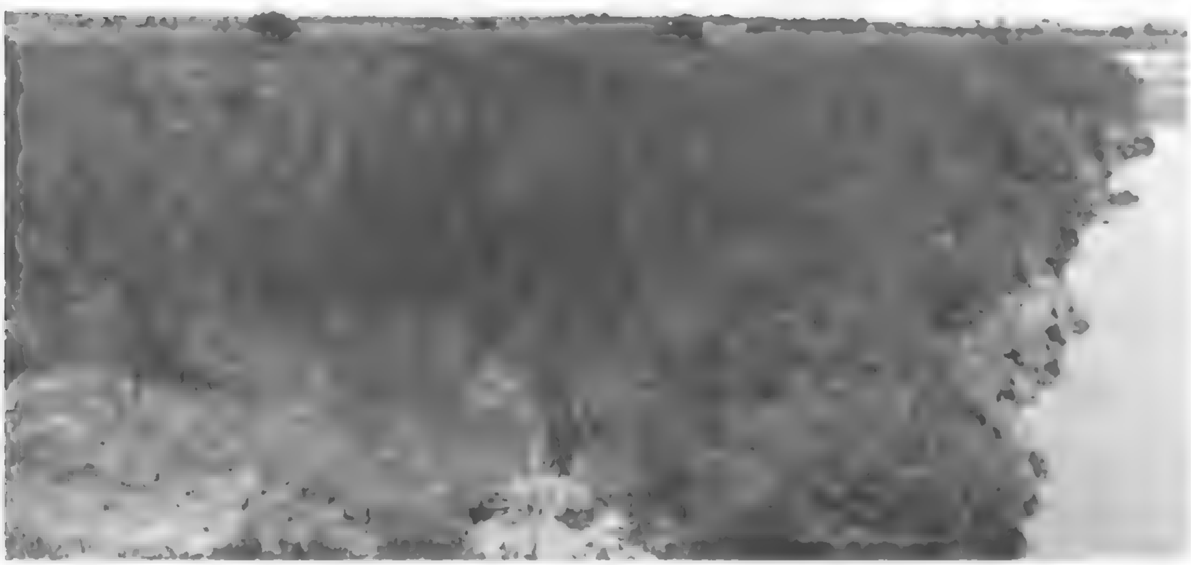

Figure 9.—Salt cedar on Lincoln fine sand, frequently flooded.

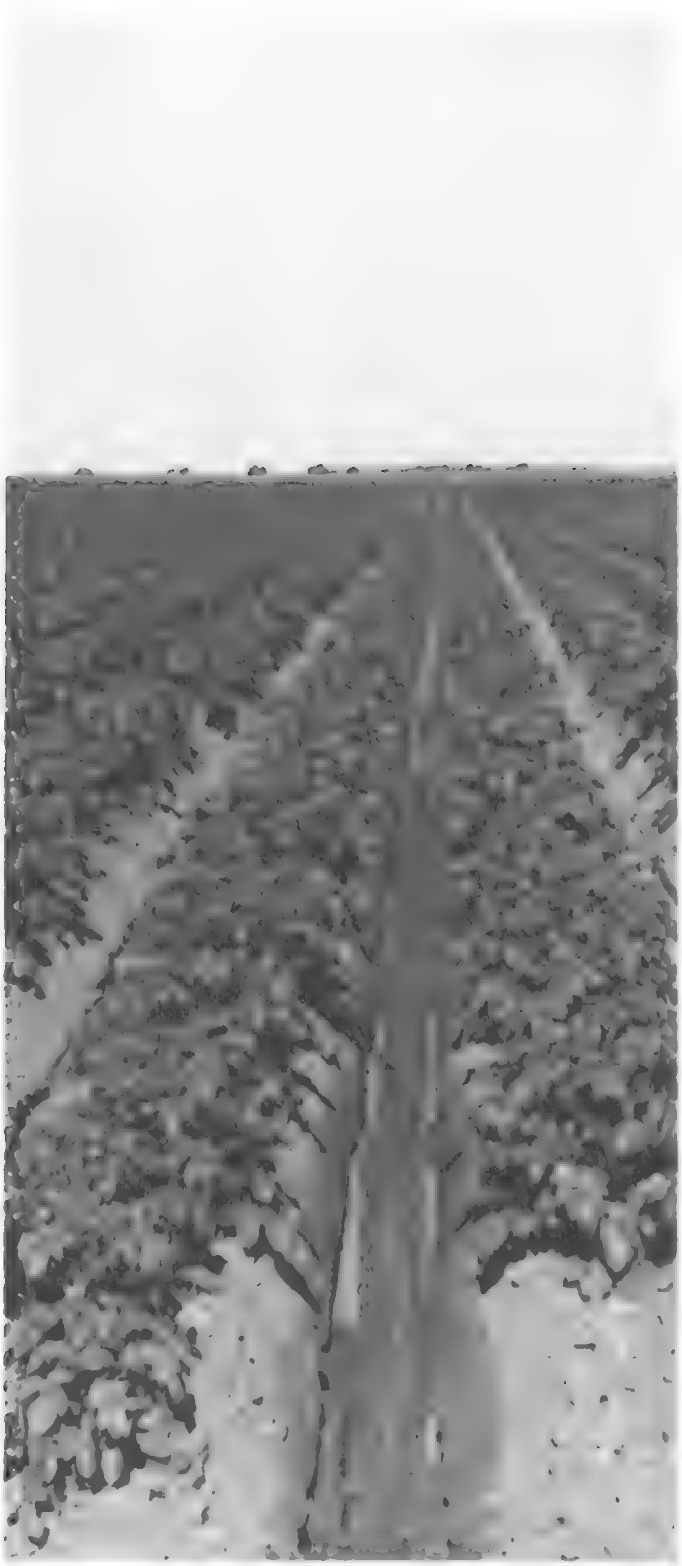

Figure 10.—Potatoes on irrigated Miles fine sandy loam, 0 to 1 percent slopes.

Figure 11.—Seedling grain sorghum on Rotan clay loam, 0 to 1 percent slopes.

Figure 12.—Area of Vernon-Owens-Knoco association, rolling.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA

[Recorded in the period 1940-69 at Munday, Texas]

Month	Temperature						Precipitation			
	Average daily maximum	Average daily minimum	Average	Average number of days with-- Maximum temperature 90° and higher	Average number of days with-- Minimum temperature 32° and lower	Average number of heating degree days[1]	Average	Greatest daily	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F				In	In		In
Jan--	57.0	30.2	43.6	0	19	661	0.96	1.78	2	2.0
Feb--	61.5	34.3	47.9	2	14	510	1.17	1.47	3	1.8
Mar--	69.5	40.0	54.8	2	8	350	1.12	1.90	3	1.2
Apr--	79.8	51.4	65.6	6	1	88	2.50	5.00	4	.3
May--	86.0	59.8	72.9	13	0	14	3.80	3.05	6	.0
Jun--	93.3	68.2	80.8	23	0	2	2.98	3.16	5	.0
Jul--	97.7	71.4	84.6	28	0	0	2.34	3.08	4	.0
Aug--	97.9	70.3	84.1	29	0	2	2.06	3.50	3	.0
Sep--	89.7	63.0	76.4	15	0	3	2.88	3.41	4	.0
Oct--	79.9	52.8	66.4	5	2	82	2.52	4.13	4	.3
Nov--	67.6	40.5	54.1	2	5	327	1.38	2.31	2	0.3
Dec--	58.9	33.2	46.1	0	15	588	1.18	1.56	3	1.3
Year-	78.2	51.3	64.8	125	64	2,627	24.89	5.00	43	7.2

[1] A heating degree day is a unit of heat related to the energy required for space heating in homes and buildings. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature above which heating is not necessary (65° F).

[2] Less than one-half.

[3] Trace, an amount too small to measure.

TABLE 2.--POTENTIALS AND LIMITATIONS OF MAP UNITS ON THE GENERAL SOIL MAP FOR SPECIFIED USES

Map unit	Percentage of county	Cultivated crops	Range	Urban uses	Recreation
1. Knoco-Vernon	30	Low: Water erosion, complex slopes, low available water capacity, depth to rock.	Medium: Water erosion, low available water capacity.	Low: Shrink-swell, low strength, depth to rock.	Low: Too clayey, complex slopes.
2. Miles-Rotan	26	High	High	High	High.
3. Tillman-Hollister-Wichita.	23	High	High	Medium: Shrink-swell, low strength, slow percolation, corrosivity.	Medium: Too clayey, slow percolation.
4. Cottonwood-Knoco	7	Low: Water erosion, complex slopes, low available water capacity, depth to rock.	Low: Water erosion, low available water capacity.	Low: Shrink-swell, low strength, slow percolation, corrosivity.	Low: Too clayey, slow percolation.
5. Hardeman-Enterprise-Lincoln.	7	High	High	Low: Flooding, seepage.	High.
6. Clairemont-Mangum	4	Low: Flooding.	High	Low: Flooding.	Medium: Flooding, dusty.
7. Miles-Springer	3	High	High	High	Medium: Too sandy, soil blowing.

TABLE 3.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1	Altus fine sandy loam, 0 to 1 percent slopes	9,900	1.8
2	Aspermont silty clay loam, 1 to 3 percent slopes	5,500	1.0
3	Aspermont silty clay loam, 3 to 5 percent slopes	6,500	1.2
4	Aspermont silty clay loam, 5 to 12 percent slopes	3,100	0.6
5	Clairemont silt loam, occasionally flooded	3,900	0.7
6	Clairemont silt loam, frequently flooded	15,400	2.8
7	Cobb fine sandy loam, 0 to 1 percent slopes	1,500	0.3
8	Cobb fine sandy loam, 1 to 3 percent slopes	6,400	1.2
9	Cosh fine sandy loam, 1 to 5 percent slopes	9,900	1.8
10	Cottonwood-Knoco association, rolling	37,400	6.8
11	Enterprise very fine sandy loam, 0 to 1 percent slopes	9,200	1.7
12	Enterprise very fine sandy loam, 1 to 3 percent slopes	3,112	0.6
13	Hardeman fine sandy loam, 0 to 1 percent slopes	3,600	0.6
14	Hardeman fine sandy loam, 1 to 3 percent slopes	4,700	0.8
15	Hardeman fine sandy loam, 3 to 5 percent slopes	4,800	0.9
16	Hardeman fine sandy loam, 5 to 12 percent slopes	7,200	1.3
17	Hollister clay loam, 0 to 1 percent slopes	19,900	3.6
18	Knoco-Badland association, undulating	102,900	18.7
19	Lincoln fine sand, frequently flooded	4,100	0.7
20	Lincoln-Yahola complex, occasionally flooded	9,200	1.7
21	Mangum clay, occasionally flooded	2,900	0.5
22	Mangum clay, frequently flooded	20,200	3.7
23	Miles loamy fine sand, 0 to 3 percent slopes	8,800	1.6
24	Miles loamy fine sand, 3 to 5 percent slopes	2,400	0.4
25	Miles fine sandy loam, 0 to 1 percent slopes	43,400	7.9
26	Miles fine sandy loam, 1 to 3 percent slopes	24,300	4.4
27	Randall clay	600	0.1
28	Rotan clay loam, 0 to 1 percent slopes	22,500	4.1
29	Rotan-Winters-Miles complex, 0 to 1 percent slopes	8,900	1.6
30	Rowena clay loam, 0 to 1 percent slopes	2,900	0.5
31	Sagerton clay loam, 0 to 1 percent slopes	13,800	2.5
32	Sagerton clay loam, 1 to 3 percent slopes	2,100	0.4
33	Springer loamy fine sand, 0 to 3 percent slopes	4,200	0.8
34	Tillman clay loam, 0 to 1 percent slopes	15,800	2.9
35	Tillman clay loam, 1 to 3 percent slopes	17,300	3.1
36	Tobosa clay, 0 to 1 percent slopes	6,200	1.1
37	Vernon clay, 1 to 3 percent slopes	6,900	1.2
38	Vernon clay, 3 to 8 percent slopes	19,100	3.5
39	Vernon-Owens-Knoco association, rolling	19,600	3.6
40	Weymouth Variant clay loam, 1 to 3 percent slopes	800	0.1
41	Weymouth Variant clay loam, 3 to 5 percent slopes	1,000	0.2
42	Wichita clay loam, 0 to 1 percent slopes	10,100	1.8
43	Wichita clay loam, 1 to 3 percent slopes	8,900	1.6
44	Wichita clay loam, 3 to 5 percent slopes	2,900	0.5
45	Winters fine sandy loam, 0 to 1 percent slopes	7,800	1.4
46	Yahola fine sandy loam, occasionally flooded	2,900	0.5
	Water	6,528	1.2
	Total	551,040	100.0

TABLE 4.--YIELDS PER ACRE OF CROPS

[Yields in the N columns are for nonirrigated soils; those in the I columns are for irrigated soils. Yields are those that can be expected under a high level of management. The estimates were made in 1974. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Cotton lint		Grain sorghum		Wheat	
	N	I	N	I	N	I
	Lb	Lb	Bu	Bu	Bu	Bu
1 Altus	400	700	50	85	30	50
2 Aspermont	200	---	20	---	15	---
3 Aspermont	150	---	15	---	12	---
4 Aspermont	---	---	35	---	45	---
5, 6. Clairemont						
7 Cobb	250	---	25	---	20	---
8 Cobb	200	---	20	---	18	---
9 Cosh	---	---	15	---	10	---
10*:						
Cottonwood part	---	---	---	---	---	---
Knoco part	---	---	---	---	---	---
11 Enterprise	325	750	45	100	25	55
12 Enterprise	300	650	35	90	25	50
13 Hardeman	275	650	35	75	20	45
14 Hardeman	250	600	30	65	20	40
15 Hardeman	200	500	25	50	15	35
16 Hardeman	---	---	---	---	---	---
17 Hollister	250	725	30	85	25	55
18*:						
Knoco part	---	---	---	---	---	---
Badland part.						
19 Lincoln	---	---	---	---	---	---
20 Lincoln	---	---	37	---	25	---
21 Mangum	150	---	20	---	15	---

See footnote at end of table.

TABLE 4.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Cotton lint		Grain sorghum		Wheat	
	N	I	N	I	N	I
	Lb	Lb	Bu	Bu	Bu	Bu
22 Mangum	---	---	---	---	---	---
23 Miles	250	650	25	75	15	35
24 Miles	---	---	20	65	15	---
25 Miles	300	700	35	85	20	50
26 Miles	250	650	30	75	20	45
27 Randall	---	---	---	---	---	---
28 Rotan	300	775	35	115	25	60
29 Rotan	300	775	35	115	25	60
30 Rowena	250	---	35	---	25	---
31 Sagerton	250	750	30	115	25	60
32 Sagerton	225	700	25	100	20	50
33 Springer	225	600	25	75	---	---
34 Tillman	250	---	30	---	25	---
35 Tillman	225	---	25	---	20	---
36 Tobosa	250	---	30	---	20	---
37 Vernon	---	---	17	---	15	---
38 Vernon	---	---	---	---	---	---
39*:						
Vernon part	---	---	---	---	---	---
Owens part	---	---	---	---	---	---
Knoco part	---	---	---	---	---	---
40 Weymouth Variant	200	---	20	---	15	---
41 Weymouth Variant	150	---	15	---	12	---
42 Wichita	250	725	30	115	25	60

See footnote at end of table.

TABLE 4.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Cotton lint		Grain sorghum		Wheat	
	N	I	N	I	N	I
	Lb	Lb	Bu	Bu	Bu	Bu
43----------------------- Wichita	225	700	25	100	20	50
44----------------------- Wichita	200	650	20	85	15	40
45----------------------- Winters	300	725	55	115	25	60
46----------------------- Yahola	425	750	50	100	30	60

* See map unit description for the composition and behavior of the map unit.

TABLE 5.--CAPABILITY CLASSES AND SUBCLASSES

[All soils are assigned to nonirrigated capability subclasses (N). Only those potentially irrigable soils are assigned to irrigated subclasses (I). Miscellaneous areas are excluded. Absence of an entry indicates no acreage]

Class	Total acreage	Major management concerns (Subclass)			
		Erosion (e)	Wetness (w)	Soil problem (s)	Climate (c)
		Acres	Acres	Acres	Acres
I (N)	---	---	---	---	---
(I)	95,100	---	---	---	---
II (N)	193,112	80,312	9,700	15,800	87,300
(I)	150,712	125,212	9,700	15,800	---
III (N)	85,900	79,700	---	6,200	---
(I)	20,700	20,700	---	---	---
IV (N)	35,900	26,700	---	9,200	---
(I)	21,500	12,300	---	9,200	---
V (N)	39,700	---	39,700	---	---
VI (N)	49,600	49,000	600	---	---
VII (N)	140,300	---	---	140,300	---
VIII(N)	---	---	---	---	---

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
1 Altus	Sandy Loam	Favorable	3,800	Little bluestem	25
		Normal	2,800	Sand bluestem	20
		Unfavorable	2,000	Sideoats grama	15
				Blue grama	10
				Indiangrass	5
				Texas wintergrass	5
				Sand lovegrass	5
				Sand sagebrush	5
2, 3, 4 Aspermont	Clay Loam	Favorable	2,000	Blue grama	25
		Normal	1,600	Buffalograss	15
		Unfavorable	1,200	Sideoats grama	10
				Vine-mesquite	10
				Arizona cottontop	5
				Texas wintergrass	5
				Sand dropseed	5
				Western wheatgrass	5
5, 6 Clairemont	Loamy Bottomland	Favorable	3,400	Sideoats grama	20
		Normal	2,600	Sand bluestem	10
		Unfavorable	1,800	Indiangrass	10
				Vine-mesquite	10
				Switchgrass	5
				Little bluestem	5
				Western wheatgrass	5
				Arizona cottontop	5
				Texas wintergrass	5
				Plains bristlegrass	5
7, 8 Cobb	Sandy Loam	Favorable	3,000	Sideoats grama	20
		Normal	2,400	Blue grama	20
		Unfavorable	1,800	Little bluestem	10
				Plains bristlegrass	10
				Vine-mesquite	10
				Arizona cottontop	5
				Sand dropseed	5
				Buffalograss	5
9 Cosh	Sandy Loam	Favorable	2,200	Sideoats grama	20
		Normal	1,750	Little bluestem	15
		Unfavorable	1,200	Plains bristlegrass	15
				Blue grama	10
				Vine-mesquite	10
				Arizona cottontop	10
				Sand dropseed	5
				Buffalograss	5
10*:					
Cottonwood part	Gyp	Favorable	900	Sideoats grama	20
		Normal	650	Little bluestem	10
		Unfavorable	300	Sand bluestem	5
				Indiangrass	5
				Plains bristlegrass	5
				Vine-mesquite	5
				Arizona cottontop	5
				Tobosa	5
				Blue grama	5
				Hairy grama	5
				Buffalograss	5
				Black grama	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
10*:					
Knoco part	Shallow Clay	Favorable	1,400	Sideoats grama	30
		Normal	1,000	Tobosa	15
		Unfavorable	600	Buffalograss	10
				Vine-mesquite	5
				Hairy grama	5
				Silver bluestem	5
				Arizona cottontop	5
				Purple threeawn	5
				Rough tridens	5
				Blue grama	5
11, 12 Enterprise	Sandy Loam	Favorable	3,000	Sideoats grama	20
		Normal	2,400	Little bluestem	15
		Unfavorable	1,700	Plains bristlegrass	15
				Blue grama	10
				Vine-mesquite	10
				Arizona cottontop	10
				Sand dropseed	5
				Buffalograss	5
13, 14, 15, 16 Hardeman	Sandy Loam	Favorable	3,000	Sideoats grama	20
		Normal	2,400	Little bluestem	15
		Unfavorable	1,800	Plains bristlegrass	15
				Blue grama	10
				Vine-mesquite	10
				Arizona cottontop	10
				Sand dropseed	5
				Buffalograss	5
17 Hollister	Clay Loam	Favorable	2,400	Sideoats grama	20
		Normal	1,800	Vine-mesquite	20
		Unfavorable	1,300	Buffalograss	15
				Arizona cottontop	10
				Western wheatgrass	10
				Blue grama	10
				Tobosa	5
18*:					
Knoco part	Shallow Clay	Favorable	1,400	Sideoats grama	30
		Normal	1,000	Tobosa	15
		Unfavorable	600	Buffalograss	10
				Vine-mesquite	5
				Hairy grama	5
				Silver bluestem	5
				Arizona cottontop	5
				Purple threeawn	5
				Rough tridens	5
				Blue grama	5
Badland part.					
19 Lincoln	Sandy Bottomland	Favorable	3,000	Switchgrass	30
		Normal	2,280	Sand bluestem	15
		Unfavorable	1,800	Indiangrass	15
				Little bluestem	5
				Texas bluegrass	5
				Beaked panicum	5
				Purpletop	5
				Maximilian sunflower	5
				Goldenrod	5
				Heath aster	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production		Characteristic vegetation	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
20*:					
Lincoln part	Sandy Bottomland	Favorable	3,000	Switchgrass	30
		Normal	2,280	Sand bluestem	15
		Unfavorable	1,800	Indiangrass	15
				Little bluestem	5
				Texas bluegrass	5
				Beaked panicum	5
				Purpletop	5
				Maximilian sunflower	5
				Goldenrod	5
				Heath aster	5
Yahola part	Loamy Bottomland	Favorable	7,000	Big bluestem	25
		Normal	4,900	Indiangrass	15
		Unfavorable	3,500	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5
				Tall dropseed	5
				Beaked panicum	5
				Compassplant	5
				Sedge	5
				Heath aster	5
21, 22 Mangum	Clayey Bottomland	Favorable	2,200	Tobosa	40
		Normal	1,500	Buffalograss	15
		Unfavorable	800	Vine-mesquite	10
				Alkali sacaton	10
				Sideoats grama	5
				Western wheatgrass	5
				White tridens	5
				Blue grama	5
23, 24 Miles	Loamy Sand	Favorable	3,200	Little bluestem	15
		Normal	2,300	Sand bluestem	15
		Unfavorable	1,500	Sideoats grama	10
				Plains bristlegrass	10
				Indiangrass	10
				Arizona cottontop	5
				Silver bluestem	5
				Hooded windmillgrass	5
				Switchgrass	5
25, 26 Miles	Sandy Loam	Favorable	2,800	Blue grama	20
		Normal	2,250	Sideoats grama	20
		Unfavorable	1,800	Plains bristlegrass	10
				Arizona cottontop	10
				Little bluestem	5
				Silver bluestem	5
				Hooded windmillgrass	5
				Buffalograss	5
				Vine-mesquite	5
27 Randall	Lakebed	Favorable	3,000	Pennsylvania smartweed	20
		Normal	1,200	Blue grama	15
		Unfavorable	500	Common spikesedge	15
				Buffalograss	15
				Western wheatgrass	10
				Knotgrass	5
28 Rotan	Clay Loam	Favorable	2,500	Sideoats grama	20
		Normal	2,000	Vine-mesquite	15
		Unfavorable	1,500	Arizona cottontop	15
				Buffalograss	10
				Western wheatgrass	5
				Silver bluestem	5
				Texas wintergrass	5
				Tobosa	5
				White tridens	5
				Blue grama	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
29*:					
Rotan part	Clay Loam	Favorable	2,500	Sideoats grama	20
		Normal	2,000	Vine-mesquite	15
		Unfavorable	1,500	Arizona cottontop	15
				Buffalograss	10
				Western wheatgrass	5
				Silver bluestem	5
				Texas wintergrass	5
				Tobosa	5
				White tridens	5
				Blue grama	5
Winters part	Sandy Loam	Favorable	3,000	Sideoats grama	20
		Normal	2,500	Blue grama	15
		Unfavorable	1,800	Little bluestem	10
				Plains bristlegrass	10
				Arizona cottontop	10
				Vine-mesquite	10
				Hooded windmillgrass	5
				Buffalograss	5
Miles part	Sandy Loam	Favorable	2,800	Blue grama	20
		Normal	2,250	Sideoats grama	20
		Unfavorable	1,800	Plains bristlegrass	10
				Arizona cottontop	10
				Little bluestem	5
				Silver bluestem	5
				Hooded windmillgrass	5
				Buffalograss	5
				Vine-mesquite	5
30 Rowena	Clay Loam	Favorable	2,500	Sideoats grama	20
		Normal	2,000	Arizona cottontop	15
		Unfavorable	1,400	Vine-mesquite	15
				Buffalograss	10
				Blue grama	5
				Plains bristlegrass	5
				Silver bluestem	5
				Texas wintergrass	5
				White tridens	5
31, 32 Sagerton	Clay Loam	Favorable	2,600	Sideoats grama	20
		Normal	2,000	Vine-mesquite	15
		Unfavorable	1,400	Arizona cottontop	15
				Buffalograss	10
				Western wheatgrass	5
				Silver bluestem	5
				Texas wintergrass	5
				Tobosa	5
				Blue grama	5
				Sand dropseed	5
33 Springer	Loamy Sand	Favorable	3,300	Little bluestem	15
		Normal	2,500	Sand bluestem	15
		Unfavorable	1,600	Sideoats grama	10
				Plains bristlegrass	10
				Indiangrass	10
				Arizona cottontop	5
				Sand dropseed	5
				Hooded windmillgrass	5
				Switchgrass	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production		Characteristic vegetation	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
34, 35 Tillman	Clay Loam	Favorable	2,200	Sideoats grama	20
		Normal	1,700	Vine-mesquite	15
		Unfavorable	1,200	Arizona cottontop	10
				Buffalograss	10
				Western wheatgrass	5
				Silver bluestem	5
				Texas wintergrass	5
				Tobosa	5
				White tridens	5
				Blue grama	5
36 Tobosa	Clay Flat	Favorable	3,000	Tobosa	40
		Normal	2,500	Buffalograss	15
		Unfavorable	1,000	Sideoats grama	10
				Curlymesquite	5
				Cane bluestem	5
				Vine-mesquite	5
				Texas wintergrass	5
				Wright threeawn	5
37, 38 Vernon	Shallow Clay	Favorable	1,750	Sideoats grama	25
		Normal	1,350	Buffalograss	15
		Unfavorable	900	Tobosa	15
				Vine-mesquite	5
				Hairy grama	5
				Silver bluestem	5
				Arizona cottontop	5
				Blue grama	5
39*:					
Vernon part	Shallow Clay	Favorable	1,750	Sideoats grama	25
		Normal	1,350	Buffalograss	15
		Unfavorable	900	Tobosa	15
				Vine-mesquite	5
				Hairy grama	5
				Silver bluestem	5
				Arizona cottontop	5
				Blue grama	5
Owens part	Shallow Clay	Favorable	2,500	Sideoats grama	30
		Normal	2,000	Silver bluestem	15
		Unfavorable	1,000	Buffalograss	10
				Vine-mesquite	10
				Texas wintergrass	5
				Arizona cottontop	5
				Hairy grama	5
				Rough tridens	5
Knoco part	Shallow Clay	Favorable	1,400	Sideoats grama	30
		Normal	1,000	Tobosa	15
		Unfavorable	600	Buffalograss	10
				Vine-mesquite	5
				Hairy grama	5
				Silver bluestem	5
				Arizona cottontop	5
				Purple threeawn	5
				Rough tridens	5
				Blue grama	5
40, 41 Weymouth Variant	Clay Loam	Favorable	2,000	Blue grama	30
		Normal	1,600	Buffalograss	15
		Unfavorable	1,200	Sideoats grama	10
				Vine-mesquite	5
				Tobosa	5
				Texas wintergrass	5
				Sand dropseed	5
				Western wheatgrass	5
				Arizona cottontop	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
42, 43, 44 Wichita	Clay Loam	Favorable	2,600	Sideoats grama	20
		Normal	2,000	Vine-mesquite	15
		Unfavorable	1,400	Buffalograss	15
				Arizona cottontop	10
				Western wheatgrass	10
				Blue grama	10
				Tobosa	5
				Texas wintergrass	5
45 Winters	Sandy Loam	Favorable	3,000	Sideoats grama	20
		Normal	2,500	Blue grama	15
		Unfavorable	1,800	Little bluestem	10
				Plains bristlegrass	10
				Arizona cottontop	10
				Vine-mesquite	10
				Hooded windmillgrass	5
				Buffalograss	5
46 Yahola	Loamy Bottomland	Favorable	7,000	Big bluestem	25
		Normal	4,900	Indiangrass	15
		Unfavorable	3,500	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5
				Tall dropseed	5
				Beaked panicum	5
				Compassplant	5
				Sedge	5
				Heath aster	5

* See map unit description for the composition and behavior of the map unit.

TABLE 7.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
1-----Altus	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.
2-----Aspermont	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: low strength, shrink-swell.
3-----Aspermont	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Moderate: low strength, shrink-swell.
4-----Aspermont	Moderate: slope, too clayey.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Moderate: slope, low strength, shrink-swell.
5, 6-----Clairemont	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
7, 8-----Cobb	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.
9-----Cosh	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.
10*:					
Cottonwood part	Moderate: slope, depth to rock.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Moderate: slope, depth to rock.
Knoco part	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
11, 12-----Enterprise	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.
13, 14-----Hardeman	Slight	Slight	Slight	Slight	Moderate: low strength.
15-----Hardeman	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength.
16-----Hardeman	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope.
17-----Hollister	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
18*:					
Knoco part	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Badland part.					
19-----Lincoln	Severe: floods, cutbanks cave.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.

See footnote at end of table.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
20*:					
Lincoln part	Severe: floods, cutbanks cave.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
Yahola part	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods, low strength.
21, 22 Mangum	Severe: floods, too clayey.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.
23 Miles	Slight	Slight	Slight	Slight	Moderate: low strength.
24 Miles	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength.
25, 26 Miles	Slight	Slight	Slight	Slight	Moderate: low strength.
27 Randall	Severe: too clayey, wetness.	Severe: shrink-swell, wetness, floods.	Severe: shrink-swell, wetness, floods.	Severe: shrink-swell, wetness, floods.	Severe: shrink-swell, wetness, floods.
28 Rotan	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
29*:					
Rotan part	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
Winters part	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
Miles part	Slight	Slight	Slight	Slight	Moderate: low strength.
30 Rowena	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
31, 32 Sagerton	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength, shrink-swell.
33 Springer	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
34, 35 Tillman	Severe: too clayey.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.
36 Tobosa	Severe: too clayey, cutbanks cave.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
37, 38 Vernon	Severe: too clayey.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.

See footnote at end of table.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
39*:					
Vernon part	Severe: too clayey.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.
Owens part	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: shrink-swell.
Knoco part	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
40, 41 Weymouth Variant	Severe: depth to rock.	Moderate: low strength.	Severe: depth to rock.	Moderate: low strength.	Moderate: low strength.
42, 43, 44 Wichita	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: shrink-swell, low strength.
45 Winters	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
46 Yahola	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods, low strength.

* See map unit description for the composition and behavior of the map unit.

TABLE 8.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," and "fair." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1 Altus	Slight	Moderate: seepage.	Slight	Slight	Good.
2, 3 Aspermont	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
4 Aspermont	Moderate: slope, percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: slope, too clayey.
5, 6 Clairemont	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
7, 8 Cobb	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Slight	Fair: thin layer.
9 Cosh	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight	Poor: thin layer.
10*:					
Cottonwood part	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Moderate: slope.	Poor: thin layer.
Knoco part	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey.
11, 12 Enterprise	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
13, 14, 15 Hardeman	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
16 Hardeman	Moderate: slope.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: slope.
17 Hollister	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey.
18*:					
Knoco part	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Slight	Poor: too clayey.
Badland part.					
19 Lincoln	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.	Fair: too sandy.
20*:					
Lincoln part	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.	Fair: too sandy.
Yahola part	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.	Good.
21, 22 Mangum	Severe: floods, percs slowly.	Severe: floods.	Severe: floods.	Severe: floods.	Poor: too clayey.

See footnote at end of table.

TABLE 8.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
23------ Miles	Slight------	Moderate: seepage.	Slight------	Slight------	Good.
24------ Miles	Slight------	Moderate: seepage, slope.	Slight------	Slight------	Good.
25------ Miles	Slight------	Moderate: seepage.	Slight------	Slight------	Good.
26------ Miles	Slight------	Moderate: seepage, slope.	Slight------	Slight------	Good.
27------ Randall	Severe: floods, wetness, percs slowly.	Slight------	Severe: floods, wetness, too clayey.	Severe: floods.	Poor: too clayey, wetness.
28------ Rotan	Severe: percs slowly.	Slight------	Moderate: too clayey.	Slight------	Poor: too clayey.
29*:					
Rotan part------	Severe: percs slowly.	Slight------	Moderate: too clayey.	Slight------	Poor: too clayey.
Winters part------	Moderate: percs slowly.	Slight------	Moderate: too clayey.	Slight------	Fair: too clayey.
Miles part------	Slight------	Moderate: seepage.	Slight------	Slight------	Good.
30------ Rowena	Severe: percs slowly.	Slight------	Severe: too clayey.	Slight------	Poor: too clayey.
31------ Sagerton	Moderate: percs slowly.	Slight------	Moderate: too clayey.	Slight------	Fair: too clayey.
32------ Sagerton	Moderate: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight------	Fair: too clayey.
33------ Springer	Slight------	Severe: seepage.	Slight------	Slight------	Fair: too sandy.
34------ Tillman	Severe: percs slowly.	Slight------	Severe: too clayey.	Slight------	Poor: too clayey.
35------ Tillman	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight------	Poor: too clayey.
36------ Tobosa	Severe: percs slowly.	Slight------	Severe: too clayey.	Slight------	Poor: too clayey.
37, 38------ Vernon	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight------	Poor: too clayey.
39*:					
Vernon part------	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Slight------	Poor: too clayey.
Owens part------	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, area reclaim.
Knoco part------	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey.

See footnote at end of table.

TABLE 8.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
40, 41-------------- Weymouth Variant	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight-----------	Fair: thin layer, too clayey.
42------------------ Wichita	Severe: percs slowly.	Slight-----------	Moderate: too clayey.	Slight-----------	Fair: too clayey.
43, 44-------------- Wichita	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
45------------------ Winters	Moderate: percs slowly.	Slight-----------	Moderate: too clayey.	Slight-----------	Fair: too clayey.
46------------------ Yahola	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.	Good.

* See map unit description for the composition and behavior of the map unit.

TABLE 9.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1----- Altus	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
2, 3----- Aspermont	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
4----- Aspermont	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope, too clayey.
5, 6----- Clairemont	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
7, 8----- Cobb	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
9----- Cosh	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
10*:				
Cottonwood part-----	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer, excess salt.
Knoco part-----	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
11, 12----- Enterprise	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
13, 14, 15----- Hardeman	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
16----- Hardeman	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope.
17----- Hollister	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
18*:				
Knoco part-----	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
Badland part.				
19----- Lincoln	Good-----	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
20*:				
Lincoln part-----	Good-----	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
Yahola part-----	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Good.
21, 22----- Mangum	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.

See footnote at end of table.

TABLE 9.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
23, 24----------------- Miles	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too sandy.
25, 26----------------- Miles	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
27--------------------- Randall	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
28--------------------- Rotan	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
29*:				
Rotan part------------	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Winters part----------	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Miles part------------	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
30--------------------- Rowena	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
31, 32----------------- Sagerton	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
33--------------------- Springer	Good------------------	Poor: excess fines.	Unsuited: excess fines.	Poor: too sandy.
34, 35----------------- Tillman	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
36--------------------- Tobosa	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
37, 38----------------- Vernon	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
39*:				
Vernon part-----------	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
Owens part------------	Poor: shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
Knoco part------------	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
40, 41----------------- Weymouth Variant	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
42, 43, 44------------- Wichita	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
45--------------------- Winters	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
46--------------------- Yahola	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Good.

* See map unit description for the composition and behavior of the map unit.

TABLE 10.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
1 Altus	Moderate: seepage.	Moderate: unstable fill, piping, compressible.	Favorable	Favorable	Favorable.
2, 3, 4 Aspermont	Moderate: seepage.	Slight	Slope, erodes easily.	Slope	Erodes easily, slope.
5, 6 Clairemont	Moderate: seepage.	Slight	Floods	Not needed	Erodes easily.
7, 8 Cobb	Severe: depth to rock.	Moderate: thin layer.	Erodes easily, rooting depth.	Depth to rock	Rooting depth.
9 Cosh	Severe: depth to rock.	Severe: thin layer.	Rooting depth, slope, droughty.	Depth to rock, rooting depth.	Rooting depth, droughty.
10*:					
Cottonwood part	Severe: depth to rock, seepage.	Severe: unstable fill, seepage, thin layer.	Droughty, rooting depth, excess salt.	Depth to rock, rooting depth.	Droughty, rooting depth, excess salt.
Knoco part	Slight	Moderate: low strength, shrink-swell.	Not needed	Not needed	Not needed.
11, 12 Enterprise	Severe: seepage.	Moderate: piping, unstable fill.	Fast intake	Erodes easily	Favorable.
13, 14, 15, 16 Hardeman	Severe: seepage.	Moderate: unstable fill, piping, low strength.	Fast intake, slope.	Seepage, erodes easily, slope.	Erodes easily, slope.
17 Hollister	Slight	Moderate: unstable fill, compressible, shrink-swell.	Slow intake	Percs slowly	Percs slowly, droughty.
18*:					
Knoco part	Slight	Moderate: low strength, shrink-swell.	Not needed	Not needed	Not needed.
Badland part.					
19 Lincoln	Severe: seepage.	Moderate: unstable fill, piping.	Seepage, fast intake.	Not needed	Favorable.
20*:					
Lincoln part	Severe: seepage.	Moderate: unstable fill, piping.	Seepage, fast intake.	Not needed	Favorable.
Yahola part	Severe: seepage.	Moderate: unstable fill, seepage, piping.	Floods	Not needed	Not needed.

See footnote at end of table.

TABLE 10.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Irrigation	Terraces and diversions	Grassed waterways
21, 22 Mangum	Slight	Moderate: shrink-swell, compressible.	Floods, slow intake.	Not needed	Not needed.
23, 24, 25, 26 Miles	Moderate: seepage.	Slight	Fast intake, soil blowing, slope.	Soil blowing	Favorable.
27 Randall	Slight	Moderate: unstable fill, hard to pack.	Slow intake, wetness.	Not needed	Not needed.
28 Rotan	Moderate: seepage.	Moderate: compressible, piping.	Slow intake	Favorable	Favorable.
29*:					
Rotan part	Moderate: seepage.	Moderate: compressible, piping.	Slow intake	Favorable	Favorable.
Winters part	Moderate: seepage.	Moderate: compressible, piping.	Slow intake, slope.	Favorable	Percs slowly.
Miles part	Moderate: seepage.	Slight	Fast intake, soil blowing, slope.	Soil blowing	Favorable.
30 Rowena	Moderate: seepage.	Moderate: unstable fill.	Favorable	Favorable	Favorable.
31, 32 Sagerton	Moderate: seepage.	Moderate: piping.	Slow intake	Favorable	Favorable.
33 Springer	Severe: seepage.	Moderate: seepage, piping.	Fast intake, erodes easily.	Too sandy, erodes easily.	Erodes easily.
34, 35 Tillman	Slight	Moderate: compressible, low strength, shrink-swell.	Percs slowly, slow intake.	Percs slowly	Droughty, percs slowly.
36 Tobosa	Slight	Moderate: compressible, unstable fill.	Slow intake	Percs slowly	Percs slowly.
37, 38 Vernon	Slight	Moderate: hard to pack.	Slow intake, percs slowly, droughty.	Favorable	Droughty, percs slowly, slope.
39*:					
Vernon part	Slight	Moderate: hard to pack.	Slow intake, percs slowly, droughty.	Favorable	Droughty, percs slowly, slope.
Owens part	Slight	Moderate: compressible.	Droughty, percs slowly.	Slope, rooting depth.	Droughty, erodes easily.
Knoco part	Slight	Moderate: low strength, shrink-swell.	Not needed	Not needed	Not needed.
40, 41 Weymouth Variant	Severe: depth to rock.	Moderate: thin layer, low strength.	Rooting depth	Rooting depth	Rooting depth.

See footnote at end of table.

TABLE 10.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Irrigation	Terraces and diversions	Grassed waterways
42, 43, 44-------- Wichita	Moderate: seepage.	Moderate: compressible, piping.	Slow intake------	Favorable--------	Favorable.
45---------------- Winters	Moderate: seepage.	Moderate: compressible, piping.	Slow intake, slope.	Favorable--------	Percs slowly.
46---------------- Yahola	Severe: seepage.	Moderate: unstable fill, seepage, piping.	Floods-----------	Not needed-------	Not needed.

* See map unit description for the composition and behavior of the map unit.

TABLE 11.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
1 Altus	Slight	Slight	Slight	Slight.
2, 3 Aspermont	Slight	Slight	Moderate: too clayey, slope.	Slight.
4 Aspermont	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
5 Clairemont	Severe: floods.	Slight	Moderate: floods.	Slight.
6 Clairemont	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.
7, 8 Cobb	Slight	Slight	Moderate: depth to rock.	Slight.
9 Cosh	Slight	Slight	Severe: depth to rock.	Slight.
10*:				
Cottonwood part	Moderate: slope, dusty.	Moderate: slope, dusty.	Severe: slope.	Moderate: dusty.
Knoco part	Severe: too clayey, percs slowly.	Severe: too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey.
11 Enterprise	Slight	Slight	Slight	Slight.
12 Enterprise	Slight	Slight	Moderate: slope.	Slight.
13 Hardeman	Slight	Slight	Slight	Slight.
14, 15 Hardeman	Slight	Slight	Moderate: slope.	Slight.
16 Hardeman	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
17 Hollister	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: percs slowly, too clayey.	Moderate: too clayey.
18*:				
Knoco part	Severe: too clayey, percs slowly.	Severe: too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey.
Badland part.				
19 Lincoln	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
20*:				
Lincoln part	Severe: floods.	Moderate: floods.	Moderate: floods.	Moderate: floods.
Yahola part	Severe: floods.	Moderate: floods.	Moderate: floods.	Slight.

See footnote at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
21-------------------- Mangum	Severe: floods, percs slowly.	Severe: too clayey.	Severe: percs slowly, floods.	Severe: too clayey.
22-------------------- Mangum	Severe: floods, percs slowly.	Severe: floods.	Severe: percs slowly, floods.	Severe: floods.
23-------------------- Miles	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
24-------------------- Miles	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
25-------------------- Miles	Slight---------------	Slight---------------	Slight---------------	Slight.
26-------------------- Miles	Slight---------------	Slight---------------	Moderate: slope.	Slight.
27-------------------- Randall	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
28-------------------- Rotan	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: too clayey, percs slowly.	Moderate: too clayey.
29*:				
Rotan part-----------	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: too clayey, percs slowly.	Moderate: too clayey.
Winters part---------	Moderate: percs slowly.	Slight---------------	Moderate: percs slowly.	Slight.
Miles part-----------	Slight---------------	Slight---------------	Slight---------------	Slight.
30-------------------- Rowena	Moderate: percs slowly.	Moderate: too clayey.	Moderate: too clayey, percs slowly.	Moderate: too clayey.
31-------------------- Sagerton	Moderate: percs slowly.	Moderate: too clayey.	Moderate: percs slowly.	Moderate: too clayey.
32-------------------- Sagerton	Moderate: percs slowly.	Moderate: too clayey.	Moderate: slope, percs slowly.	Moderate: too clayey.
33-------------------- Springer	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
34, 35---------------- Tillman	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: percs slowly, too clayey.	Moderate: too clayey.
36-------------------- Tobosa	Severe: percs slowly, too clayey.	Severe: too clayey.	Severe: percs slowly, too clayey.	Severe: too clayey.
37, 38---------------- Vernon	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Severe: too clayey.	Moderate: too clayey.
39*:				
Vernon part----------	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Severe: slope, too clayey.	Moderate: too clayey.

See footnote at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
39*:				
Owens part	Severe: too clayey, percs slowly.	Severe: too clayey.	Severe: slope, too clayey.	Severe: too clayey.
Knoco part	Severe: too clayey, percs slowly.	Severe: too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey.
40, 41 Weymouth Variant	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope, too clayey, depth to rock.	Moderate: too clayey.
42, 43, 44 Wichita	Moderate: percs slowly.	Moderate: too clayey.	Moderate: percs slowly.	Moderate: too clayey.
45 Winters	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
46 Yahola	Severe: floods.	Moderate: floods.	Moderate: floods.	Slight.

* See map unit description for the composition and behavior of the map unit.

TABLE 12.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements				Potential as habitat for--	
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Openland wildlife	Rangeland wildlife
1----------------- Altus	Good	Good	Good	Good	Good	Good.
2, 3--------------- Aspermont	Fair	Good	Fair	Fair	Fair	Fair.
4----------------- Aspermont	Poor	Fair	Fair	Fair	Fair	Fair.
5, 6. Clairemont						
7, 8--------------- Cobb	Fair	Good	Good	Good	Good	Good.
9----------------- Cosh	Poor	Poor	Fair	Fair	Poor	Fair.
10*:						
Cottonwood part---	Very poor	Very poor	Poor	Poor	Very poor	Poor.
Knoco part--------	Very poor	Very poor	Poor	Very poor	Very poor	Very poor.
11, 12------------- Enterprise	Good	Good	Good	Good	Good	Good.
13, 14, 15--------- Hardeman	Good	Good	Good	Good	Good	Good.
16----------------- Hardeman	Fair	Good	Good	Good	Good	Good.
17----------------- Hollister	Good	Good	Fair	Fair	Good	Fair.
18*:						
Knoco part--------	Very poor	Very poor	Poor	Very poor	Very poor	Very poor.
Badland part.						
19----------------- Lincoln	Poor	Fair	Fair	Fair	Fair	Fair.
20*:						
Lincoln part------	Fair	Fair	Fair	Fair	Fair	Fair.
Yahola part-------	Good	Good	Good	Good	Good	Good.
21----------------- Mangum	Fair	Fair	Poor	Fair	Fair	Poor.
22----------------- Mangum	Poor	Fair	Poor	Fair	Poor	Poor.
23, 24------------- Miles	Fair	Good	Good	Good	Good	Good.
25, 26------------- Miles	Fair	Good	Good	Good	Good	Good.
27----------------- Randall	Poor	Poor	Fair	Poor	Poor	Poor.

See footnote at end of table.

TABLE 12.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements				Potential as habitat for--	
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Openland wildlife	Rangeland wildlife
28. Rotan	Good	Good	Fair	Good	Good	Fair.
29*:						
Rotan part	Good	Good	Fair	Good	Good	Fair.
Winters part	Good	Good	Good	Good	Good	Good.
Miles part	Fair	Good	Good	Good	Good	Good.
30. Rowena	Good	Good	Fair	Fair	Good	Fair.
31, 32. Sagerton	Good	Good	Fair	Good	Good	Fair.
33. Springer	Poor	Fair	Good	Good	Fair	Good.
34, 35. Tillman	Good	Good	Fair	Fair	Good	Fair.
36. Tobosa	Fair	Fair	Poor	Fair	Fair	Poor.
37, 38. Vernon	Fair	Fair	Poor	Fair	Fair	Fair.
39*:						
Vernon part	Fair	Fair	Poor	Fair	Fair	Fair.
Owens part	Poor	Fair	Fair	Poor	Fair	Poor.
Knoco part	Very poor	Very poor	Poor	Very poor	Very poor	Very poor.
40, 41. Weymouth Variant	Fair	Good	Fair	Fair	Fair	Fair.
42, 43. Wichita	Good	Good	Fair	Fair	Good	Fair.
44. Wichita	Fair	Good	Fair	Fair	Fair	Fair.
45. Winters	Good	Good	Good	Good	Good	Good.
46. Yahola	Good	Good	Good	Good	Good	Good.

* See map unit description for the composition and behavior of the map unit.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
1------------------ Altus	0-18	Fine sandy loam	SM, ML, SC, CL	A-4	0	100	98-100	94-100	36-60	<30	NP-10
	18-80	Fine sandy loam, sandy clay loam.	SM, ML, SC, CL	A-4, A-6	0	100	98-100	90-100	36-65	<37	NP-16
2, 3, 4------------ Aspermont	0-15	Silty clay loam	CL	A-7-6, A-6	0	100	98-100	90-100	51-90	30-45	12-28
	15-36	Loam, silty clay loam, clay loam.	CL	A-7-6, A-6	0	100	95-100	80-98	51-95	30-45	12-28
	36-60	Silt loam, loam, silty clay loam.	CL	A-4, A-6, A-7	0	100	95-100	85-100	51-95	25-45	8-30
5, 6--------------- Clairemont	0-80	Silt loam-------	CL, CL-ML	A-4, A-6	0	100	98-100	95-100	51-95	25-40	7-20
7, 8--------------- Cobb	0-6	Fine sandy loam	SM, SM-SC	A-2-4, A-4	0	90-100	90-100	75-90	30-50	17-25	3-7
	6-34	Sandy clay loam	SC, CL, SM-SC, CL-ML	A-6, A-4	0	90-100	85-100	80-98	40-60	20-40	7-20
	34-40	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
9------------------ Cosh	0-6	Fine sandy loam	SM, SM-SC	A-2-4, A-4	0-5	90-100	90-100	70-90	30-50	15-25	2-7
	6-18	Sandy clay loam	SC, CL	A-6, A-4	0-5	90-98	90-98	80-95	40-55	25-36	8-18
	18-24	Weathered bedrock.	---	---	---	---	---	---	---	---	---
10*: Cottonwood part---	0-8	Clay loam-------	CL, CL-ML	A-4, A-6	0	100	100	85-100	55-75	20-35	4-15
	8-24	Weathered bedrock.	---	---	0	---	---	---	---	---	---
Knoco part--------	0-8	Clay------------	CL, CH	A-7-6, A-6	0-5	90-100	90-100	90-100	80-98	32-60	14-38
	8-60	Shaly clay, clay	CL, CH	A-7-6, A-6	0-5	90-100	85-100	60-100	60-95	30-60	13-38
11, 12------------- Enterprise	0-72	Very fine sandy loam.	CL-ML, ML, CL	A-4, A-6	0	100	98-100	90-100	55-90	20-32	3-12
13, 14, 15, 16----- Hardeman	0-13	Fine sandy loam	ML, SM, CL-ML, SM-SC	A-4, A-2-4	0	100	98-100	70-95	30-75	16-27	2-9
	13-60	Fine sandy loam, loam.	SM, SM-SC, CL-ML, ML	A-4, A-2-4	0	100	98-100	70-95	30-70	16-25	2-7
17----------------- Hollister	0-6	Clay loam-------	CL	A-6, A-7-6	0	100	98-100	90-100	75-95	35-50	17-30
	6-62	Clay, silty clay loam, clay loam.	CL, CH	A-6, A-7-6	0	98-100	95-100	95-99	75-98	38-70	20-45
	62-80	Clay, silty clay loam, clay loam.	CL, CH	A-6, A-7-6	0	98-100	95-100	85-99	70-98	35-60	18-40

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
18*:											
Knoco part	0-8	Clay	CL, CH	A-7-6, A-6	0-5	90-100	90-100	90-100	80-98	32-60	14-38
	8-60	Shaly clay, clay	CL, CH	A-7-6, A-6	0-5	90-100	85-100	60-100	60-95	30-60	13-38
Badland part.											
19 Lincoln	0-8	Fine sand	SM, SM-SP	A-2, A-3	0	90-100	85-100	75-100	8-35	---	NP
	8-70	Fine sand, loamy fine sand.	SM, SM-SP	A-2, A-3	0	90-100	85-100	75-100	8-35	---	NP
20*:											
Lincoln part	0-8	Fine sand	SM, SM-SP	A-2, A-3	0	90-100	85-100	75-100	8-35	---	NP
	8-70	Fine sand, loamy fine sand.	SM, SM-SP	A-2, A-3	0	90-100	85-100	75-100	8-35	---	NP
Yahola part	0-12	Fine sandy loam	SM, SC, ML, CL	A-4	0	100	95-100	90-100	36-85	<30	NP-10
	12-70	Fine sandy loam, loam.	SM, SC, ML, CL	A-4	0	100	95-100	90-100	36-85	<30	NP-10
21, 22 Mangum	0-10	Clay	CL, CH	A-7-6, A-6	0	100	100	98-100	90-100	40-70	22-45
	10-60	Clay, silty clay	CL, CH	A-7-6, A-6	0	100	100	95-100	80-100	40-70	22-45
23, 24 Miles	0-12	Loamy fine sand	SM, SM-SC	A-2-4	0	95-100	90-100	80-98	15-35	<22	NP-4
	12-70	Sandy clay loam, clay loam.	CL, SC, SM-SC, CL-ML	A-4, A-6, A-2-4, A-2-6	0	95-100	90-100	90-98	30-72	20-40	4-22
25, 26 Miles	0-10	Fine sandy loam	SM, SM-SC, CL-ML, ML	A-2-4, A-4	0	95-100	90-100	80-98	25-55	18-25	2-7
	10-70	Sandy clay loam, clay loam.	CL, SC, SM-SC, CL-ML	A-4, A-6, A-2-4, A-2-6	0	95-100	90-100	90-98	30-72	20-40	4-22
27 Randall	0-70	Clay	CL, CH	A-7-6	0	100	100	95-100	75-98	41-70	22-45
28 Rotan	0-10	Clay loam	CL	A-4, A-6	0	98-100	95-100	90-100	60-90	25-35	8-16
	10-36	Clay, clay loam, silty clay loam.	CL, CH	A-7	0	98-100	95-100	90-100	70-95	41-58	20-38
	36-70	Clay loam, clay	CL	A-6, A-7	0	90-100	85-100	80-98	65-95	35-50	18-30
29*:											
Rotan part	0-10	Clay loam	CL	A-4, A-6	0	98-100	95-100	90-100	60-90	25-35	8-16
	10-36	Clay, clay loam, silty clay loam.	CL, CH	A-7	0	98-100	95-100	90-100	70-95	41-58	20-38
	36-70	Clay loam, clay	CL	A-6, A-7	0	90-100	85-100	80-98	65-95	35-50	18-30
Winters part	0-10	Fine sandy loam	SM, SM-SC	A-4	0	98-100	95-100	70-90	36-50	<25	NP-7
	10-48	Sandy clay, clay, clay loam.	CL, CH	A-7-6	0	95-100	90-100	80-100	51-75	41-52	20-30
	48-70	Clay loam, sandy clay loam, sandy clay.	CL, CH	A-6, A-7-6	0	95-100	90-100	80-100	51-75	38-52	17-30

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
29*:											
Miles part	0-10	Fine sandy loam	SM, SM-SC, CL-ML, ML	A-2-4, A-4	0	95-100	90-100	80-98	25-55	18-25	2-7
	10-70	Sandy clay loam, clay loam.	CL, SC, SM-SC, CL-ML	A-4, A-6, A-2-4, A-2-6	0	95-100	90-100	90-98	30-72	20-40	4-22
30 Rowena	0-8	Clay loam	CL	A-6, A-7	0	95-100	90-100	85-100	70-85	35-50	15-30
	8-32	Clay, clay loam	CH, CL	A-7	0	95-100	95-100	90-100	75-95	41-55	25-35
	32-70	Clay, clay loam, silty clay loam.	CH, CL	A-6, A-7	0	85-100	75-100	65-90	55-85	35-55	15-28
31, 32 Sagerton	0-8	Clay loam	CL	A-6, A-4	0	95-100	95-100	90-100	55-80	25-35	8-18
	8-36	Clay loam, clay	CL	A-6, A-7-6	0	95-100	95-100	90-100	65-95	36-50	18-30
	36-80	Clay loam, clay	CL	A-6, A-4	0	90-100	90-100	80-100	60-85	25-40	8-22
33 Springer	0-18	Loamy fine sand	SM, SP-SM, SM-SC	A-2-4, A-3	0	98-100	95-100	70-96	8-25	<22	NP-4
	18-50	Fine sandy loam	SM, SM-SC	A-2-4	0	98-100	95-100	75-99	11-35	18-25	2-7
	50-68	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2-4, A-3	0	98-100	95-100	70-96	8-25	<22	NP-4
	68-80	Fine sandy loam, sandy clay loam.	SM, SM-SC, SC	A-2-4, A-4	0	98-100	95-100	75-99	11-45	18-25	2-8
34, 35 Tillman	0-7	Clay loam	CL	A-6, A-7-6	0	100	95-100	90-100	70-95	35-50	17-30
	7-56	Clay	CL, CH	A-6, A-7-6	0	95-100	90-100	90-98	70-98	38-60	20-38
	56-80	Clay	CL, CH	A-6, A-7-6	0-5	90-100	85-100	65-95	60-95	30-60	15-38
36 Tobosa	0-60	Clay	CH	A-7-6	0-5	80-100	75-100	75-100	75-98	51-72	30-45
	60-80	Clay, silty clay	CH, CL	A-7-6	0-5	80-100	75-100	75-100	70-95	45-65	25-40
37, 38 Vernon	0-8	Clay	CL, CH	A-6, A-7-6	0	95-100	90-100	90-100	80-98	38-60	20-38
	8-32	Clay	CL, CH	A-6, A-7-6	0	95-100	90-100	90-100	80-98	38-60	20-38
	32-60	Shaly clay	CL, CH	A-6, A-7-6	0-5	90-100	85-100	65-100	65-95	30-60	15-38
39*:											
Vernon part	0-8	Clay	CL, CH	A-6, A-7-6	0	95-100	90-100	90-100	80-98	38-60	20-38
	8-32	Clay	CL, CH	A-6, A-7-6	0	95-100	90-100	90-100	80-98	38-60	20-38
	32-60	Shaly clay	CL, CH	A-6, A-7-6	0-5	90-100	85-100	65-100	65-95	30-60	15-38
Owens part	0-7	Clay	CL, CH	A-7-6	0-5	95-100	95-100	85-100	75-95	45-60	22-32
	7-15	Clay, clay loam	CL, CH	A-7-6	0-5	95-100	90-100	85-100	75-95	45-60	22-32
	15-40	Shaly clay	CL, CH	A-6, A-7-6	0-5	90-100	85-100	80-100	55-95	40-55	25-35
Knoco part	0-8	Clay	CL, CH	A-7-6, A-6	0-5	90-100	90-100	90-100	80-98	32-60	14-38
	8-60	Shaly clay, clay	CL, CH	A-7-6, A-6	0-5	90-100	85-100	60-100	60-95	30-60	13-38

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
40, 41 Weymouth Variant	0-9	Clay loam	CL	A-6, A-7-6	0	95-100	90-100	80-100	65-90	30-42	12-25
	9-32	Clay loam	CL	A-6, A-7-6	0	80-100	75-100	70-98	65-92	30-42	12-25
	32-40	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
42, 43, 44 Wichita	0-8	Clay loam	CL	A-6, A-4	0	98-100	98-100	90-100	60-80	25-36	8-18
	8-52	Clay loam, clay	CL	A-6, A-7-6	0	95-100	95-100	95-100	70-95	36-50	18-32
	52-70	Clay loam, clay	CL	A-6, A-7-6, A-4	0	95-100	90-100	85-100	70-85	25-45	8-28
45 Winters	0-10	Fine sandy loam	SM, SM-SC	A-4	0	98-100	95-100	70-90	36-50	<25	NP-7
	10-48	Sandy clay, clay, clay loam.	CL, CH	A-7-6	0	95-100	90-100	80-100	51-75	41-52	20-30
	48-70	Clay loam, sandy clay loam, sandy clay.	CL, CH	A-6, A-7-6	0	95-100	90-100	80-100	51-75	38-52	17-30
46 Yahola	0-12	Fine sandy loam	SM, SC, ML, CL	A-4	0	100	95-100	90-100	36-85	<30	NP-10
	12-70	Fine sandy loam, loam.	SM, SC, ML, CL	A-4	0	100	95-100	90-100	36-85	<30	NP-10

* See map unit description for the composition and behavior of the map unit.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than. Entries under "Erosion factors-T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Permea-bility	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
						K	T	
	In	In/hr	In/in	pH				
1----------------- Altus	0-18	2.0-6.0	0.11-0.15	6.1-7.3	Low-----------	0.24	5	3
	18-80	0.6-2.0	0.11-0.17	6.6-8.4	Low-----------	0.32		
2, 3, 4---------- Aspermont	0-15	0.6-2.0	0.16-0.22	7.9-8.4	Moderate------	0.32	4	4L
	15-36	0.6-2.0	0.12-0.18	7.9-8.4	Moderate------	0.32		
	36-60	0.6-2.0	0.10-0.18	7.9-8.4	Moderate------	0.32		
5, 6------------- Clairemont	0-80	0.6-2.0	0.16-0.22	7.9-8.4	Low-----------	0.43	5	6
7, 8------------- Cobb	0-6	2.0-6.0	0.10-0.15	6.1-7.3	Low-----------	0.24	2	3
	6-34	0.6-2.0	0.12-0.16	6.1-8.4	Low-----------	0.32		
	34-40	---	---	---	--------------	---		
9---------------- Cosh	0-6	2.0-6.0	0.10-0.14	6.1-7.8	Very low------	0.24	1	3
	6-18	0.6-2.0	0.12-0.17	6.1-7.8	Low-----------	0.32		
	18-24	---	---	---	--------------	---		
10*:								
Cottonwood part-	0-8	0.6-2.0	0.11-0.18	7.9-8.4	Low-----------	0.32	1	6
	8-24	---	---	---	--------------	---		
Knoco part------	0-8	<0.06	0.10-0.17	7.9-8.4	High----------	0.32	1	4
	8-60	<0.06	0.00-0.08	7.9-8.4	High----------	0.32		
11, 12----------- Enterprise	0-72	2.0-6.0	0.15-0.20	7.4-8.4	Low-----------	0.43	5	3
13, 14, 15, 16--- Hardeman	0-13	2.0-6.0	0.10-0.18	7.4-8.4	Very low------	0.28	5	3
	13-60	2.0-6.0	0.10-0.15	7.4-8.4	Very low------	0.28		
17--------------- Hollister	0-6	0.2-0.6	0.15-0.20	6.6-8.4	High----------	0.32	5	6
	6-62	0.06-0.2	0.12-0.18	7.4-8.4	High----------	0.32		
	62-80	0.06-0.2	0.11-0.17	7.9-8.4	High----------	0.32		
18*:								
Knoco part------	0-8	<0.06	0.10-0.17	7.9-8.4	High----------	0.32	1	4
	8-60	<0.06	0.00-0.08	7.9-8.4	High----------	0.32		
Badland part.								
19--------------- Lincoln	0-8	6.0-20	0.05-0.10	7.4-8.4	Low-----------	0.17	5	1
	8-70	6.0-20	0.05-0.10	7.9-8.4	Low-----------	0.17		
20*:								
Lincoln part----	0-8	6.0-20	0.05-0.10	7.4-8.4	Low-----------	0.17	5	1
	8-70	6.0-20	0.05-0.10	7.9-8.4	Low-----------	0.17		
Yahola part-----	0-12	2.0-6.0	0.12-0.16	7.4-8.4	Low-----------	0.32	5	3
	12-70	2.0-6.0	0.12-0.16	7.9-8.4	Low-----------	0.32		
21, 22----------- Mangum	0-10	<0.06	0.14-0.18	7.9-8.4	High----------	0.32	5	4
	10-60	<0.06	0.14-0.18	7.9-8.4	High----------	0.32		
23, 24----------- Miles	0-12	2.0-6.0	0.06-0.10	6.6-7.8	Low-----------	0.20	5	2
	12-70	0.6-2.0	0.12-0.18	6.6-8.4	Low-----------	0.32		
25, 26----------- Miles	0-10	2.0-6.0	0.10-0.15	6.6-7.8	Low-----------	0.24	5	3
	10-70	0.6-2.0	0.12-0.18	6.6-8.4	Low-----------	0.32		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
27------ Randall	0-70	<0.06	0.12-0.18	7.4-8.4	Very high-----	0.32	5	4
28------ Rotan	0-10	0.6-2.0	0.15-0.20	7.4-8.4	Moderate------	0.32	5	6
	10-36	0.2-0.6	0.14-0.18	7.4-8.4	Moderate------	0.32		
	36-70	0.6-2.0	0.12-0.16	7.9-8.4	Moderate------	0.32		
29*:								
Rotan part------	0-10	0.6-2.0	0.15-0.20	7.4-8.4	Moderate------	0.32	5	6
	10-36	0.2-0.6	0.14-0.18	7.4-8.4	Moderate------	0.32		
	36-70	0.6-2.0	0.12-0.16	7.9-8.4	Moderate------	0.32		
Winters part----	0-10	2.0-6.0	0.10-0.14	6.6-7.8	Low-----------	0.24	5	3
	10-48	0.2-0.6	0.14-0.18	7.4-8.4	Moderate------	0.28		
	48-70	0.6-2.0	0.14-0.18	7.9-8.4	Moderate------	0.24		
Miles part------	0-10	2.0-6.0	0.10-0.15	6.6-7.8	Low-----------	0.24	5	3
	10-70	0.6-2.0	0.12-0.18	6.6-8.4	Low-----------	0.32		
30------ Rowena	0-8	0.2-0.6	0.15-0.20	7.9-8.4	Moderate------	0.32	5	6
	8-32	0.2-0.6	0.14-0.18	7.9-8.4	High----------	0.32		
	32-70	0.2-0.6	0.11-0.15	7.9-8.4	High----------	0.32		
31, 32------ Sagerton	0-8	0.6-2.0	0.15-0.20	6.6-7.8	Moderate------	0.32	5	6
	8-36	0.2-0.6	0.14-0.19	6.6-8.4	Moderate------	0.32		
	36-80	0.2-0.6	0.10-0.17	7.9-8.4	Moderate------	0.32		
33------ Springer	0-18	6.0-20.0	0.06-0.10	6.6-7.8	Very low------	0.17	5	2
	18-50	2.0-6.0	0.10-0.15	6.6-8.4	Low-----------	0.20		
	50-68	6.0-20.0	0.06-0.10	6.6-8.4	Very low------	0.20		
	68-80	0.6-6.0	0.10-0.16	6.6-8.4	Low-----------	0.20		
34, 35------ Tillman	0-7	0.2-0.6	0.15-0.20	6.6-8.4	High----------	0.32	5	6
	7-56	0.06-0.2	0.12-0.18	7.4-8.4	High----------	0.32		
	56-80	0.06-0.2	0.11-0.17	7.9-8.4	High----------	0.32		
36------ Tobosa	0-60	<0.06	0.12-0.18	7.4-8.4	Very high-----	0.32	5	4
	60-80	<0.06	0.10-0.18	7.9-8.4	Very high-----	0.32		
37, 38------ Vernon	0-8	<0.06	0.10-0.17	7.9-8.4	High----------	0.32	2	4
	8-32	<0.06	0.10-0.15	7.9-8.4	High----------	0.32		
	32-60	<0.06	0.-0.10	7.9-8.4	High----------	0.32		
39*:								
Vernon part-----	0-8	<0.06	0.10-0.17	7.9-8.4	High----------	0.32	2	4
	8-32	<0.06	0.10-0.15	7.9-8.4	High----------	0.32		
	32-60	<0.06	0.-0.10	7.9-8.4	High----------	0.32		
Owens part------	0-7	<0.06	0.13-0.17	7.9-8.4	High----------	0.32	1	4
	7-15	<0.06	0.13-0.17	7.9-8.4	High----------	0.32		
	15-40	<0.06	0.03-0.08	7.9-8.4	High----------	0.37		
Knoco part------	0-8	<0.06	0.10-0.17	7.9-8.4	High----------	0.32	1	4
	8-60	<0.06	0.00-0.08	7.9-8.4	High----------	0.32		
40, 41------ Weymouth Variant	0-9	0.6-2.0	0.16-0.20	7.9-8.4	Low-----------	0.32	3	6
	9-32	0.6-2.0	0.10-0.18	7.9-8.4	Low-----------	0.32		
	32-40	---	---	---	--------------	---		
42, 43, 44------ Wichita	0-8	0.6-2.0	0.15-0.20	6.6-7.8	Moderate------	0.32	5	6
	8-52	0.2-0.6	0.15-0.20	6.6-8.4	Moderate------	0.32		
	52-70	0.2-0.6	0.12-0.18	7.9-8.4	Moderate------	0.32		
45------ Winters	0-10	2.0-6.0	0.10-0.14	6.6-7.8	Low-----------	0.24	5	3
	10-48	0.2-0.6	0.14-0.18	7.4-8.4	Moderate------	0.28		
	48-70	0.6-2.0	0.14-0.18	7.9-8.4	Moderate------	0.24		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
						K	T	
	In	In/hr	In/in	pH				
46---------------- Yahola	0-12	2.0-6.0	0.12-0.16	7.4-8.4	Low-----------	0.32	5	3
	12-70	2.0-6.0	0.12-0.16	7.9-8.4	Low-----------	0.32		

* See map unit description for the composition and behavior of the map unit.

TABLE 15.--ENGINEERING TEST DATA

[Tests performed by Texas Highway Department]

Soil name and location	Report number	Depth	Shrinkage limit	Linear shrinkage	Shrinkage ratio	Mechanical analysis[1]									Liquid limit	Plasticity index	Classification[2]	
						Percentage passing sieve--						Percentage smaller than--						
						3/4-in	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 80 (0.25 mm)	No. 200 (0.074 mm)	0.05 mm	0.005 mm	0.002 mm			AASHTO[3]	Unified[4]
		In																
Enterprise very fine sandy loam: From the intersection of Texas Highway 283 and Farm Road 143 in Knox City, 5.1 miles west on Farm Road 143, then 75 feet north in cultivated field.	72-349-R	16-41	18	3.0	1.76	100	100	100	99	96	77	57	12	9	24	6	A-4(8)	CL-ML
Hardeman fine sandy loam: North on Texas Highway 283 for 4.8 miles from the intersection with State Highway 222 in Knox City, then 0.4 mile west on county road, 450 feet south in cultivated field.	72-350-R	13-28	14	2.2	1.87	100	100	100	96	80	37	27	8	7	17	3	A-4(0)	SM
	72-351-R	28-66	15	1.4	1.86	100	100	100	96	77	31	23	10	7	17	2	A-2-4(0)	SM
Hollister clay loam: North on State Highway 283 for 9.4 miles from the intersection with State Highway 222 in Knox City, then east 1.2 miles on ranch road, then north 0.8 mile, west 0.2 mile, then 50 feet south in cultivated field.	72-343-R	6-15	14	14.8	1.90	100	99	99	98	97	91	81	44	34	46	28	A-7-6(16)	CL
	72-344-R	15-37	12	16.3	1.99	100	100	99	98	97	92	85	50	42	48	31	A-7-6(18)	CL
	72-345-R	37-62	13	16.4	1.99	100	100	99	96	95	90	82	50	45	49	32	A-7-6(18)	CL
	72-346-R	62-80	12	15.3	1.99	100	99	97	89	87	80	73	46	38	45	31	A-7-6(17)	CL

[1]Mechanical analyses according to the AASHTO designation T88. Results by this procedure frequently differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service. In the AASHTO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including the coarser than 2 mm in diameter. In the usual soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 mm in diameter is excluded from calculations of grain-size fractions. The mechanical analysis in this table are not suitable for naming textural classes for soil.

[2]Unified and AASHTO Classification made by Soil Conservation Service.

[3]Based on AASHTO designation M 145-49 (1).

[4]Based on the Unified Soil Classification System (2).

TABLE 16.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the Glossary explain terms such as "rare," "brief," "apparent," and "perched." The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	Uncoated steel	Concrete
					Ft			In			
1----------------- Altus	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low.
2, 3, 4----------- Aspermont	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low.
5, 6-------------- Clairemont	B	Common------	Very brief	Apr-Nov	>6.0	---	---	>60	---	Moderate	Low.
7, 8-------------- Cobb	B	None---------	---	---	>6.0	---	---	20-40	Rip-pable	Moderate	Low.
9----------------- Cosh	C	None---------	---	---	>6.0	---	---	12-20	Rip-pable	Low-------	Low.
10*:											
Cottonwood part--	C	None---------	---	---	>6.0	---	---	3-12	Rip-pable	High-----	Moderate.
Knoco part--------	D	None---------	---	---	>6.0	---	---	3-12	Rip-pable	High-----	Low.
11, 12------------ Enterprise	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low.
13, 14, 15, 16---- Hardeman	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low.
17---------------- Hollister	D	None---------	---	---	>6.0	---	---	>60	---	High-----	Low.
18*:											
Knoco part--------	D	None---------	---	---	>6.0	---	---	3-12	Rip-paple	High-----	Low.
Badland part.											
19---------------- Lincoln	A	Common------	Very brief to brief.	Apr-Nov	5.0-8.0	Apparent	Nov-May	>60	---	Low-------	Low.
20*:											
Lincoln part-----	A	Common------	Very brief to brief.	Apr-Nov	5.0-8.0	Apparent	Nov-May	>60	---	Low-------	Low.
Yahola part------	B	Common------	Very brief	Apr-Nov	>6.0	---	---	>60	---	Low-------	Low.
21, 22------------ Mangum	D	Rare to common.	Very brief	Apr-Nov	>6.0	---	---	>60	---	High-----	Low.
23, 24, 25, 26---- Miles	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low.
27---------------- Randall	D	Common------	Long to very long.	Apr-Nov	>6.0	---	---	>60	---	High-----	Low.
28---------------- Rotan	C	None---------	---	---	>6.0	---	---	>60	---	High-----	Low.
29*:											
Rotan part--------	C	None---------	---	---	>6.0	---	---	>60	---	High-----	Low.
Winters part-----	C	None---------	---	---	>6.0	---	---	>60	---	High-----	Low.
Miles part--------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low.
30---------------- Rowena	C	None---------	---	---	>6.0	---	---	>60	---	High-----	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	Uncoated steel	Concrete
					Ft			In			
31, 32------------ Sagerton	C	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low.
33---------------- Springer	B	None--------	---	---	>6.0	---	---	>60	---	Low-------	Low.
34, 35------------ Tillman	C	None--------	---	---	>6.0	---	---	>60	---	High-----	Low.
36---------------- Tobosa	D	None--------	---	---	>6.0	---	---	>60	---	High-----	Low.
37, 38------------ Vernon	D	None--------	---	---	>6.0	---	---	20-36	Rip-pable	High-----	Low.
39*:											
Vernon part------	D	None--------	---	---	>6.0	---	---	20-36	Rip-pable	High-----	Low.
Owens part-------	D	None--------	---	---	>6.0	---	---	10-20	Rip-pable	High-----	Low.
Knoco part-------	D	None--------	---	---	>6.0	---	---	3-12	Rip-pable	High-----	Low.
40, 41------------ Weymouth Variant	B	None--------	---	---	>6.0	---	---	20-40	Hard	Moderate	Low.
42, 43, 44-------- Wichita	C	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low.
45---------------- Winters	C	None--------	---	---	>6.0	---	---	>60	---	High-----	Low.
46---------------- Yahola	B	Common------	Very brief	Apr-Nov	>6.0	---	---	>60	---	Low------	Low.

* See map unit description for the composition and behavior of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Altus	Fine-loamy, mixed, thermic Pachic Argiustolls
Aspermont	Fine-silty, mixed, thermic Typic Ustochrepts
Clairemont	Fine-silty, mixed (calcareous), thermic Typic Ustifluvents
Cobb	Fine-loamy, mixed, thermic Udic Haplustalfs
Cosh	Loamy, mixed, thermic, shallow Udic Rhodustalfs
Cottonwood	Loamy, mixed (calcareous), thermic, shallow Ustic Torriorthents
Enterprise	Coarse-silty, mixed, thermic Typic Ustochrepts
Hardeman	Coarse-loamy, mixed, thermic Typic Ustochrepts
Hollister	Fine, mixed, thermic Pachic Paleustolls
Knoco	Clayey, mixed (calcareous), thermic, shallow Ustic Torriorthents
Lincoln	Sandy, mixed, thermic Typic Ustifluvents
Mangum	Fine, mixed (calcareous), thermic Vertic Ustifluvents
Miles	Fine-loamy, mixed, thermic Udic Paleustalfs
Owens	Clayey, mixed, thermic, shallow Typic Ustochrepts
Randall	Fine, montmorillonitic, thermic Udic Pellusterts
Rotan	Fine, mixed, thermic Pachic Paleustolls
Rowena	Fine, mixed, thermic Vertic Calciustolls
Sagerton	Fine, mixed, thermic Typic Paleustolls
Springer	Coarse-loamy, mixed, thermic Udic Paleustalfs
Tillman	Fine, mixed, thermic Typic Paleustolls
Tobosa	Fine, montmorillonitic, thermic Typic Chromusterts
Vernon	Fine, mixed, thermic Typic Ustochrepts
Weymouth Variant	Fine-loamy, mixed, thermic Typic Ustochrepts
Wichita	Fine, mixed, thermic Typic Paleustalfs
Winters	Fine, mixed, thermic Udic Paleustalfs
Yahola	Coarse-loamy, mixed (calcareous), thermic Typic Ustifluvents

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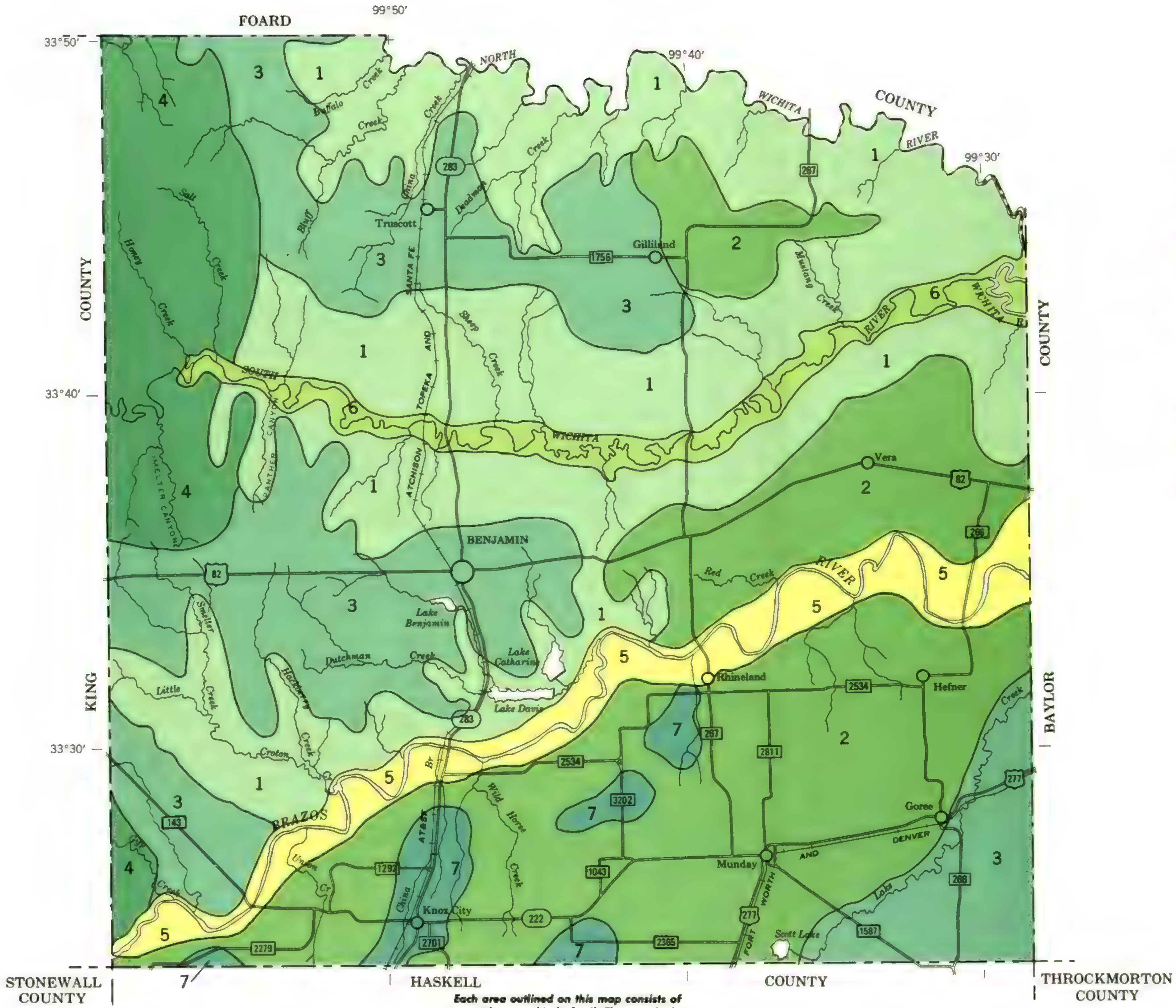


LEGEND*

1 KNOCO–VERNON: Very shallow to moderately deep, calcareous, clayey soils on uplands

2 MILES–ROTAN: Deep, noncalcareous, loamy soils on uplands

3 TILLMAN–HOLLISTER–WICHITA: Deep, calcareous, loamy soils on uplands

4 COTTONWOOD–KNOCO: Very shallow, calcareous, clayey and loamy soils on uplands

5 HARDEMAN–ENTERPRISE–LINCOLN: Deep, calcareous, loamy and sandy soils on uplands and bottom lands

6 CLAIREMONT–MANGUM: Deep, calcareous, clayey and loamy soils on bottom lands

7 MILES–SPRINGER: Deep, noncalcareous, sandy soils on uplands

*Terms for texture refer to the texture of the surface layer of the major soils

Compiled 1978

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEXAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

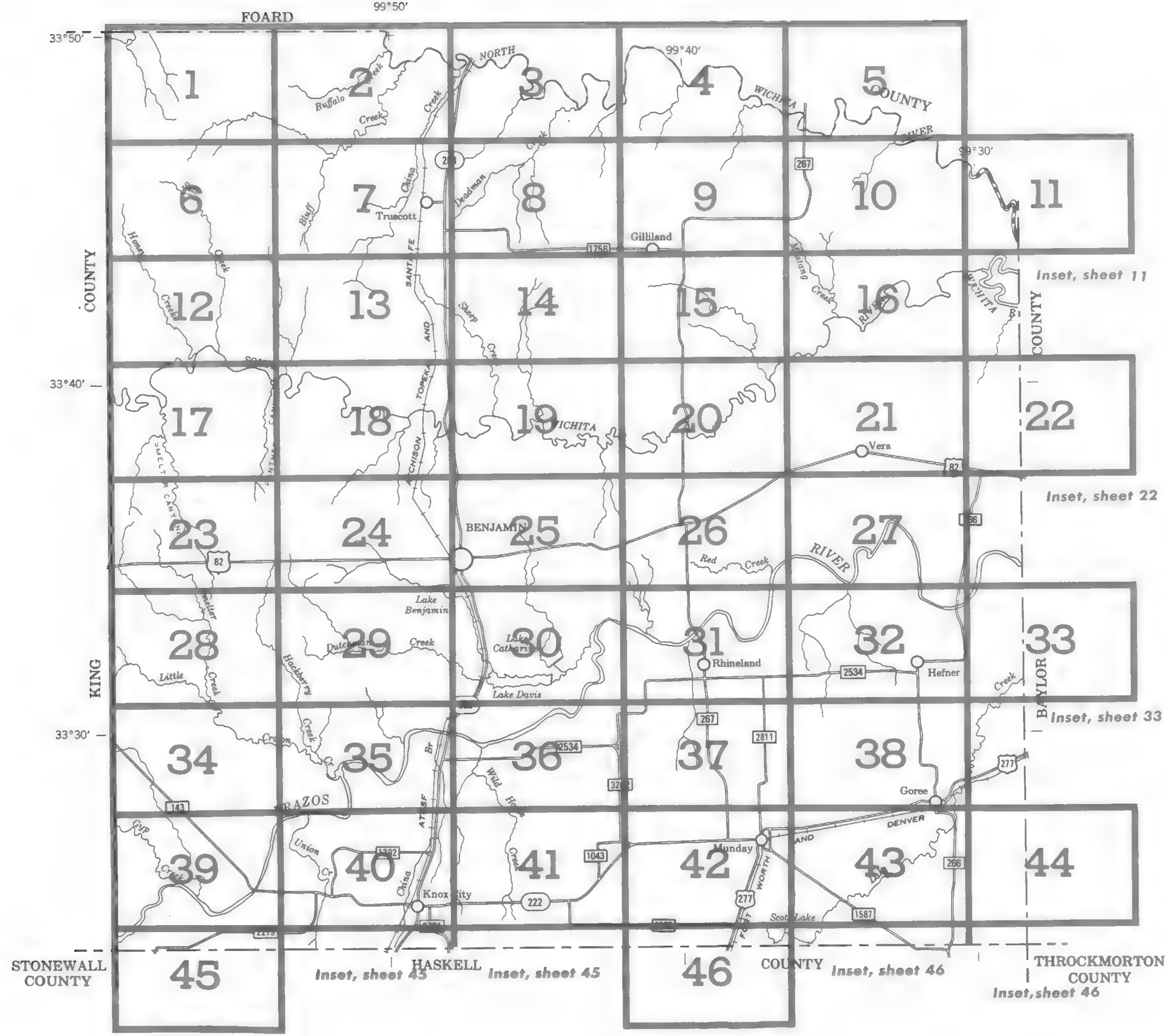
KNOX COUNTY, TEXAS

N

Scale 1:253,440

1 0 1 2 3 4 Miles

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS
KNOX COUNTY, TEXAS

Scale 1:253,440
1 0 1 2 3 4 Miles

SOIL LEGEND

Soil names followed by the superscript 1/ are broadly defined units. The composition of these units is more variable than that of the others in the survey area but has been controlled well enough to be interpreted for the expected use of the soils.

A (W) following the soil name indicates that signs of erosion, especially of local shifting of soil by wind, are evident in some places, but the degree of erosion cannot be reliably estimated.

SYMBOL	NAME
1	Altus fine sandy loam, 0 to 1 percent slopes (W)
2	Aspermont silty clay loam, 1 to 3 percent slopes
3	Aspermont silty clay loam, 3 to 5 percent slopes
4	Aspermont silty clay loam, 5 to 12 percent slopes
5	Clairemont silt loam, occasionally flooded
6	Clairemont silt loam, frequently flooded
7	Cobb fine sandy loam, 0 to 1 percent slopes
8	Cobb fine sandy loam, 1 to 3 percent slopes
9	Cosh fine sandy loam, 1 to 5 percent slopes
10	Cottonwood-Knoco association, rolling 1/
11	Enterprise very fine sandy loam, 0 to 1 percent slopes
12	Enterprise very fine sandy loam, 1 to 3 percent slopes
13	Hardeman fine sandy loam, 0 to 1 percent slopes (W)
14	Hardeman fine sandy loam, 1 to 3 percent slopes (W)
15	Hardeman fine sandy loam, 3 to 5 percent slopes (W)
16	Hardeman fine sandy loam, 5 to 12 percent slopes (W)
17	Hollister clay loam, 0 to 1 percent slopes
18	Knoco-Badland association, undulating 1/
19	Lincoln fine sand, frequently flooded
20	Lincoln-Yahola complex, occasionally flooded
21	Mangum clay, occasionally flooded
22	Mangum clay, frequently flooded
23	Miles loamy fine sand, 0 to 3 percent slopes (W)
24	Miles loamy fine sand, 3 to 5 percent slopes (W)
25	Miles fine sandy loam, 0 to 1 percent slopes (W)
26	Miles fine sandy loam, 1 to 3 percent slopes (W)
27	Randall clay
28	Rotan clay loam, 0 to 1 percent slopes
29	Rotan-Winters-Miles complex, 0 to 1 percent slopes
30	Rowena clay loam, 0 to 1 percent slopes
31	Sagerton clay loam, 0 to 1 percent slopes
32	Sagerton clay loam, 1 to 3 percent slopes
33	Springer loamy fine sand, 0 to 3 percent slopes (W)
34	Tillman clay loam, 0 to 1 percent slopes
35	Tillman clay loam, 1 to 3 percent slopes
36	Tobosa clay, 0 to 1 percent slopes
37	Vernon clay, 1 to 3 percent slopes
38	Vernon clay, 3 to 8 percent slopes
39	Vernon-Owens-Knoco association, rolling 1/
40	Weymouth Variant clay loam, 1 to 3 percent slopes
41	Weymouth Variant clay loam, 3 to 5 percent slopes
42	Wichita clay loam, 0 to 1 percent slopes
43	Wichita clay loam, 1 to 3 percent slopes
44	Wichita clay loam, 3 to 5 percent slopes
45	Winters fine sandy loam, 0 to 1 percent slopes
46	Yahola fine sandy loam, occasionally flooded

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate
- Federal
- [illegible]
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water; w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — Int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — CeA FoB2

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

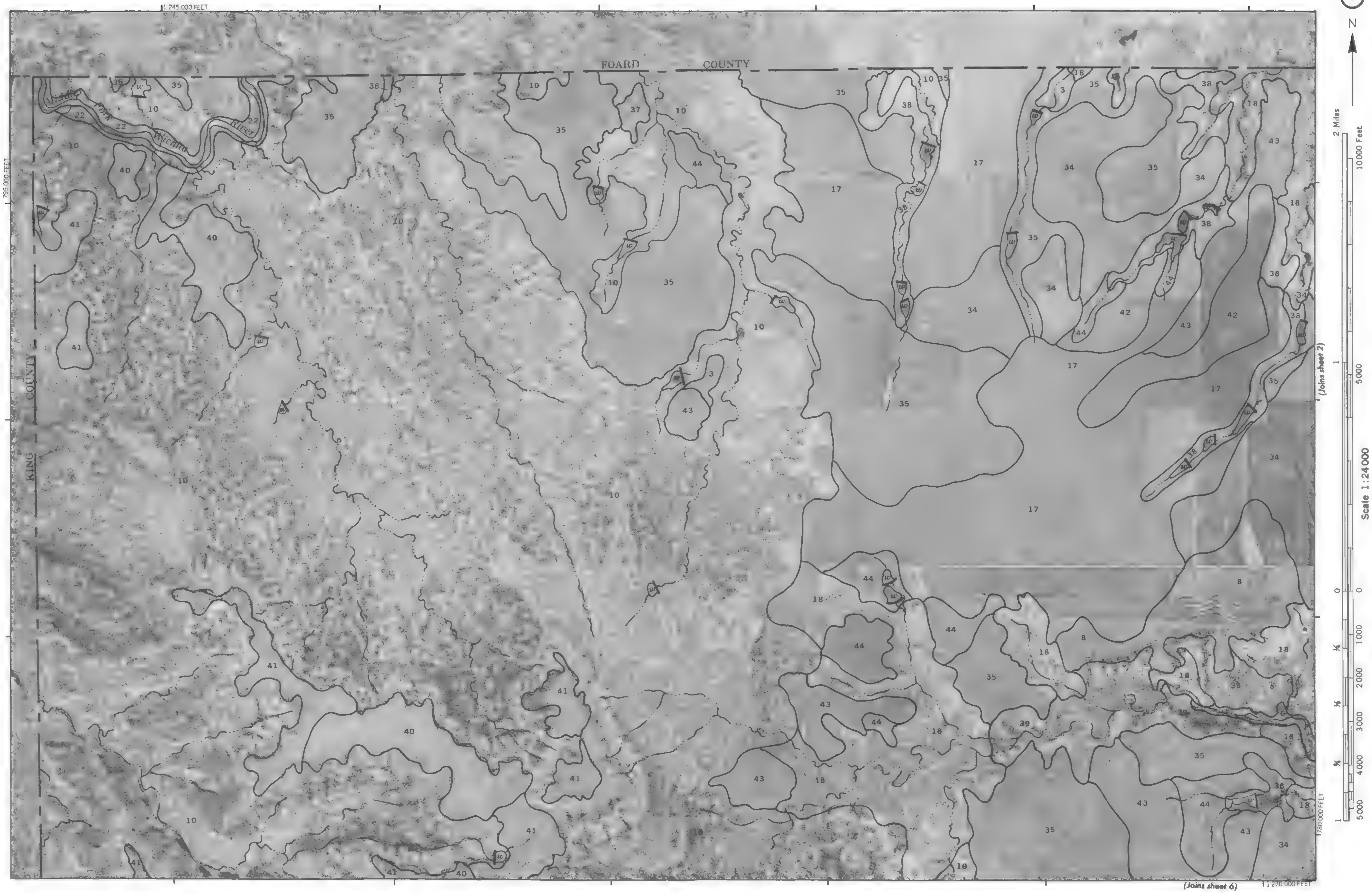
DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

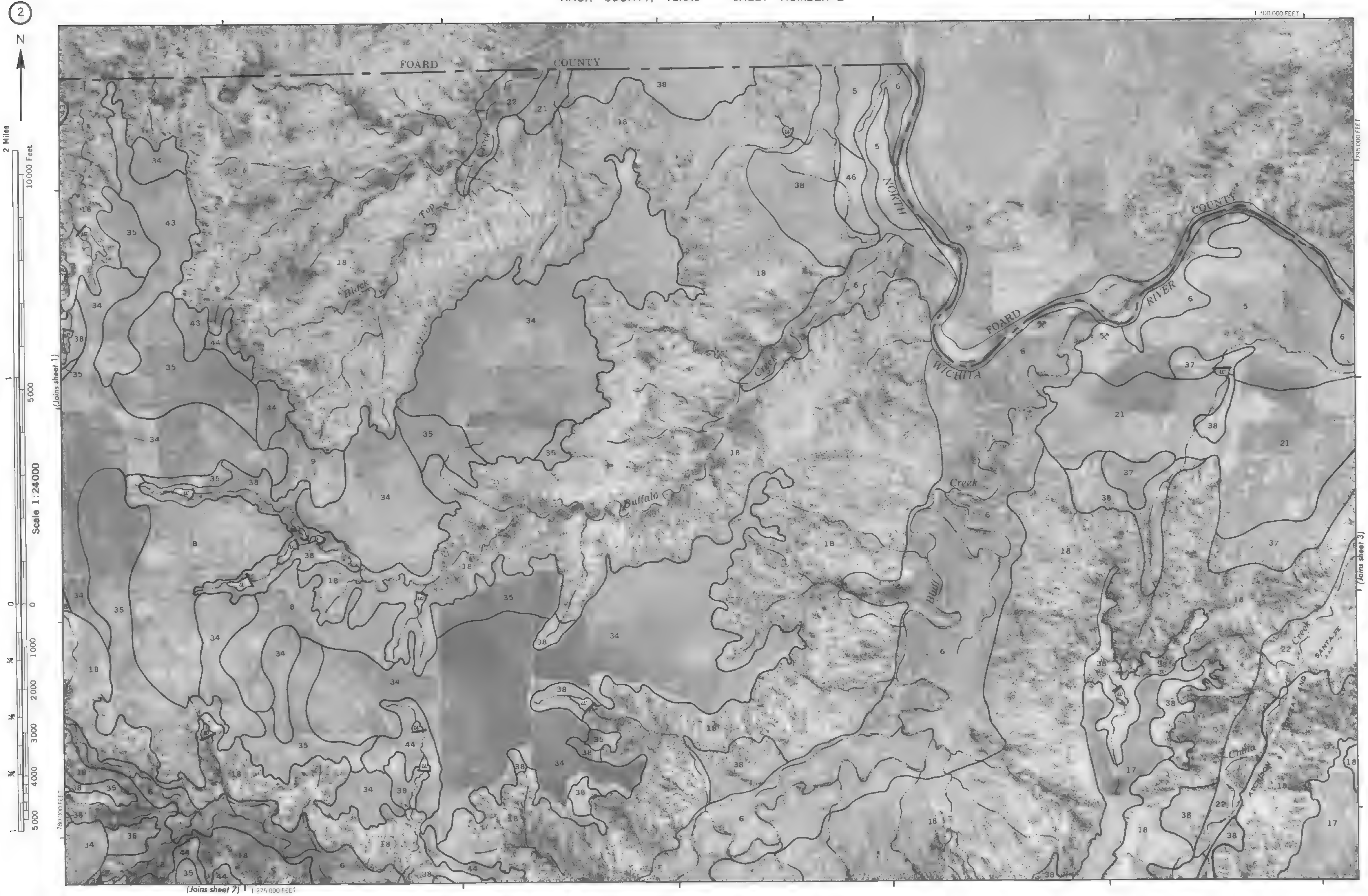
- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

KNOX COUNTY, TEXAS — SHEET NUMBER 1



KNOX COUNTY, TEXAS NO. 1

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



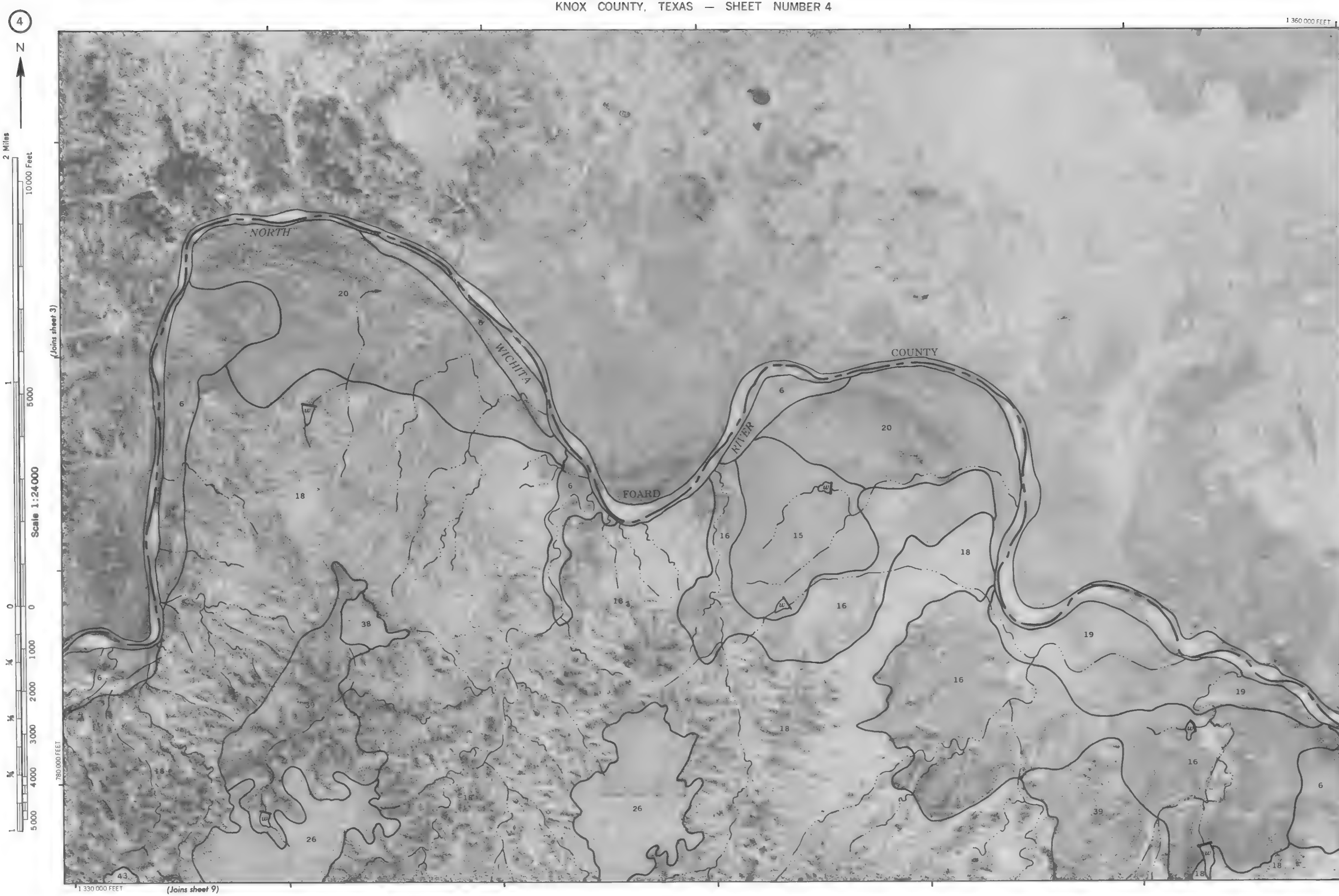
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS NO. 2

KNOX COUNTY, TEXAS NO. 3

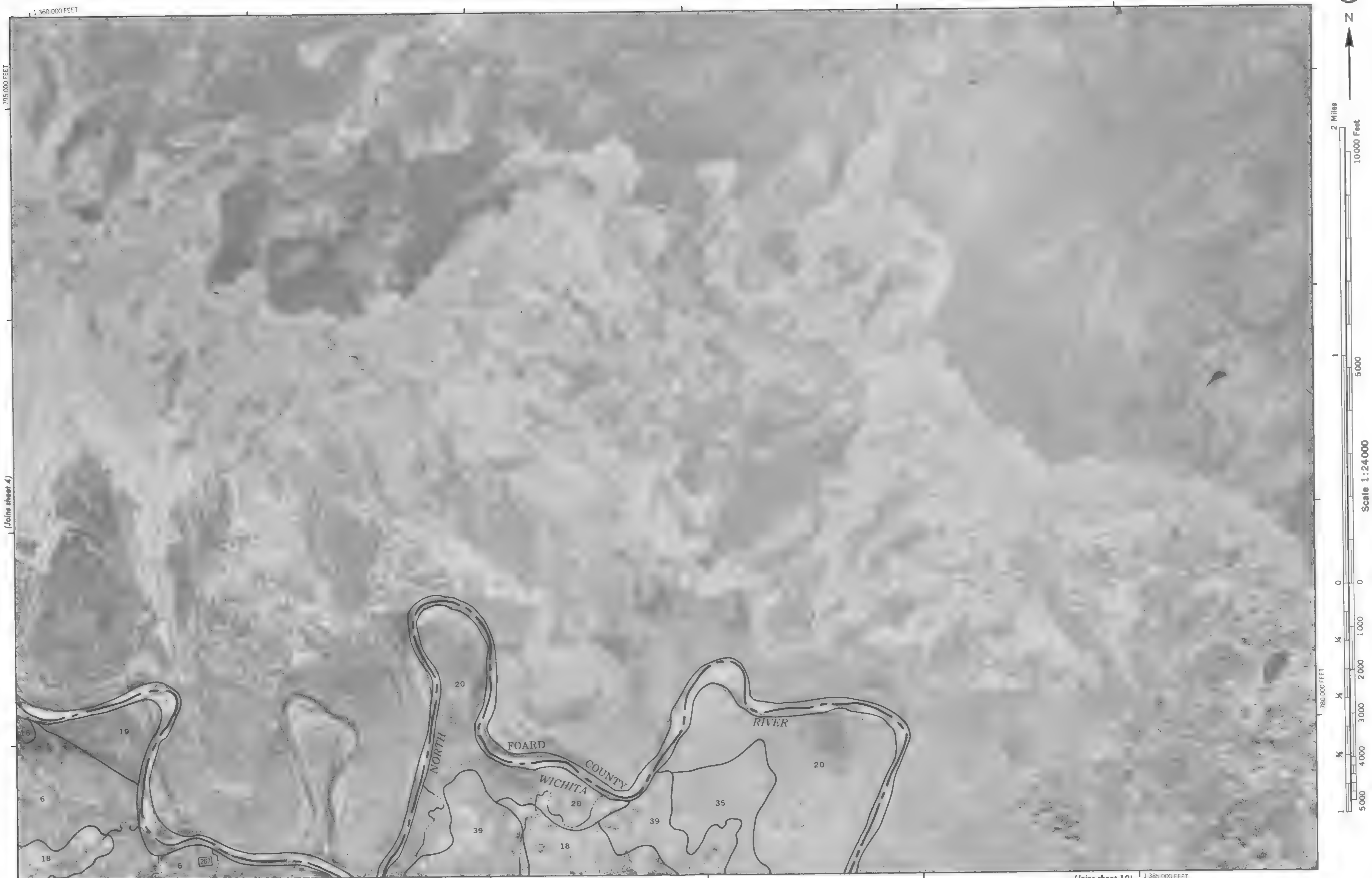
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS — SHEET NUMBER 4



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

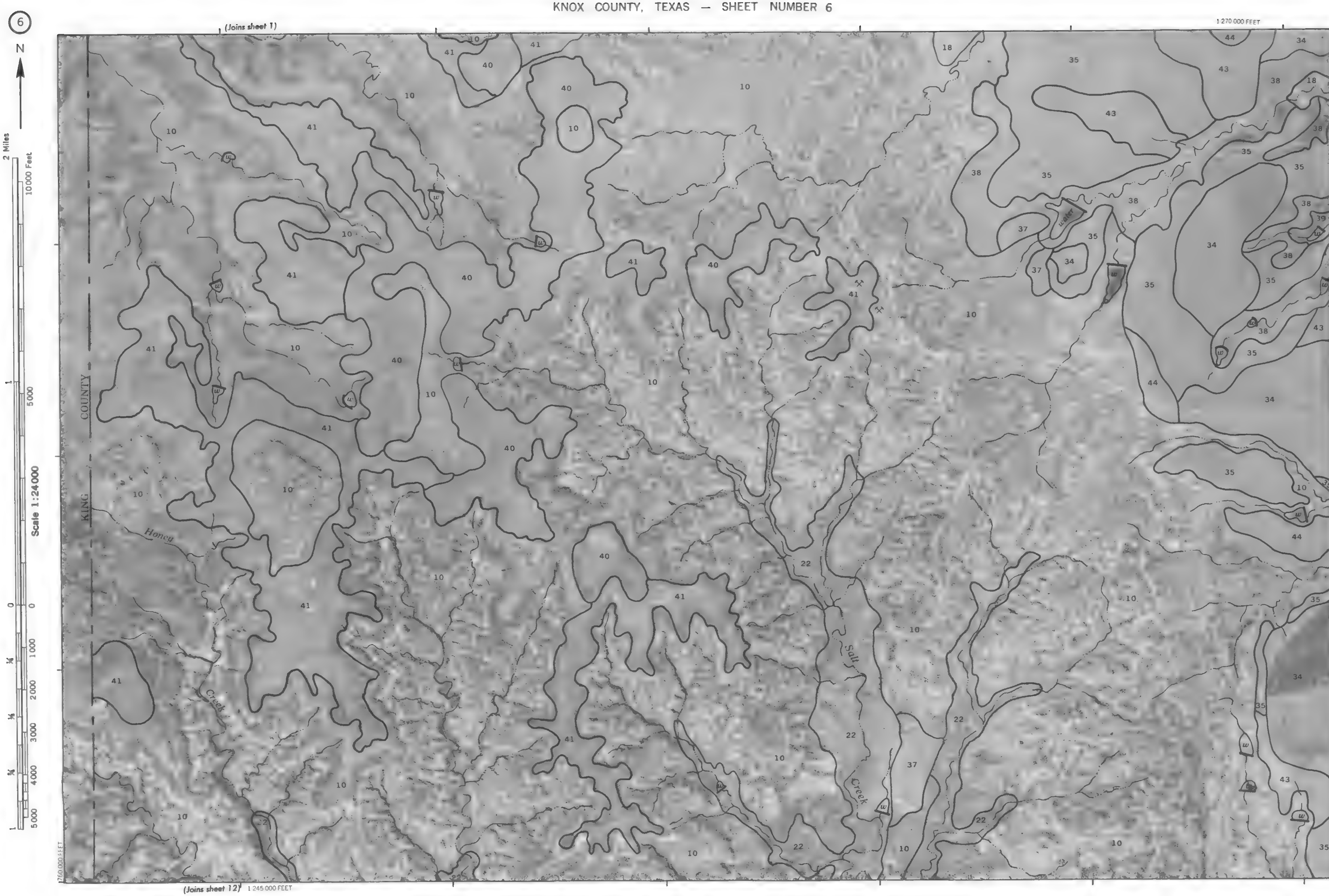
KNOX COUNTY, TEXAS NO. 4



KNOX COUNTY, TEXAS NO. 5

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS — SHEET NUMBER 6

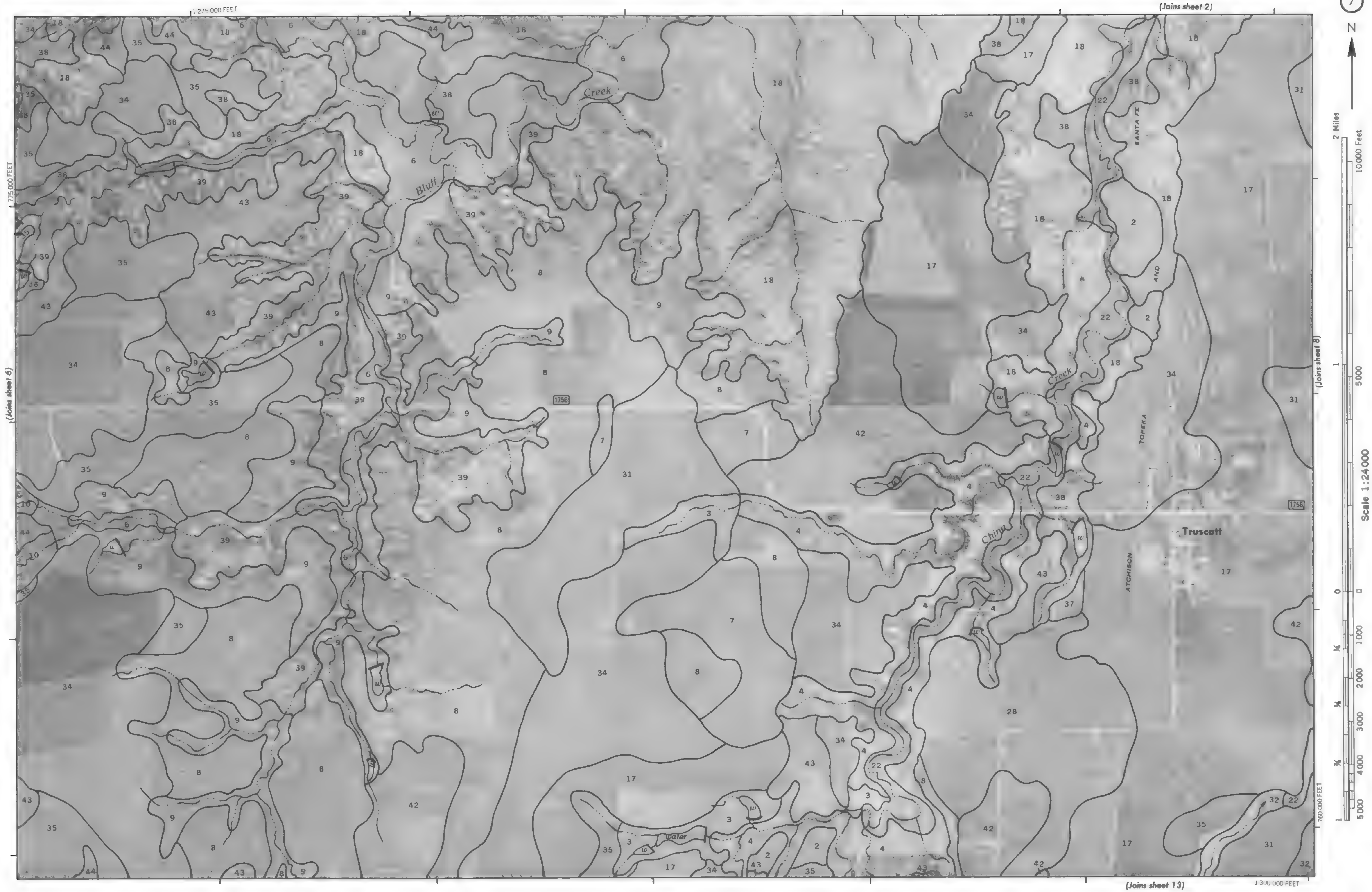


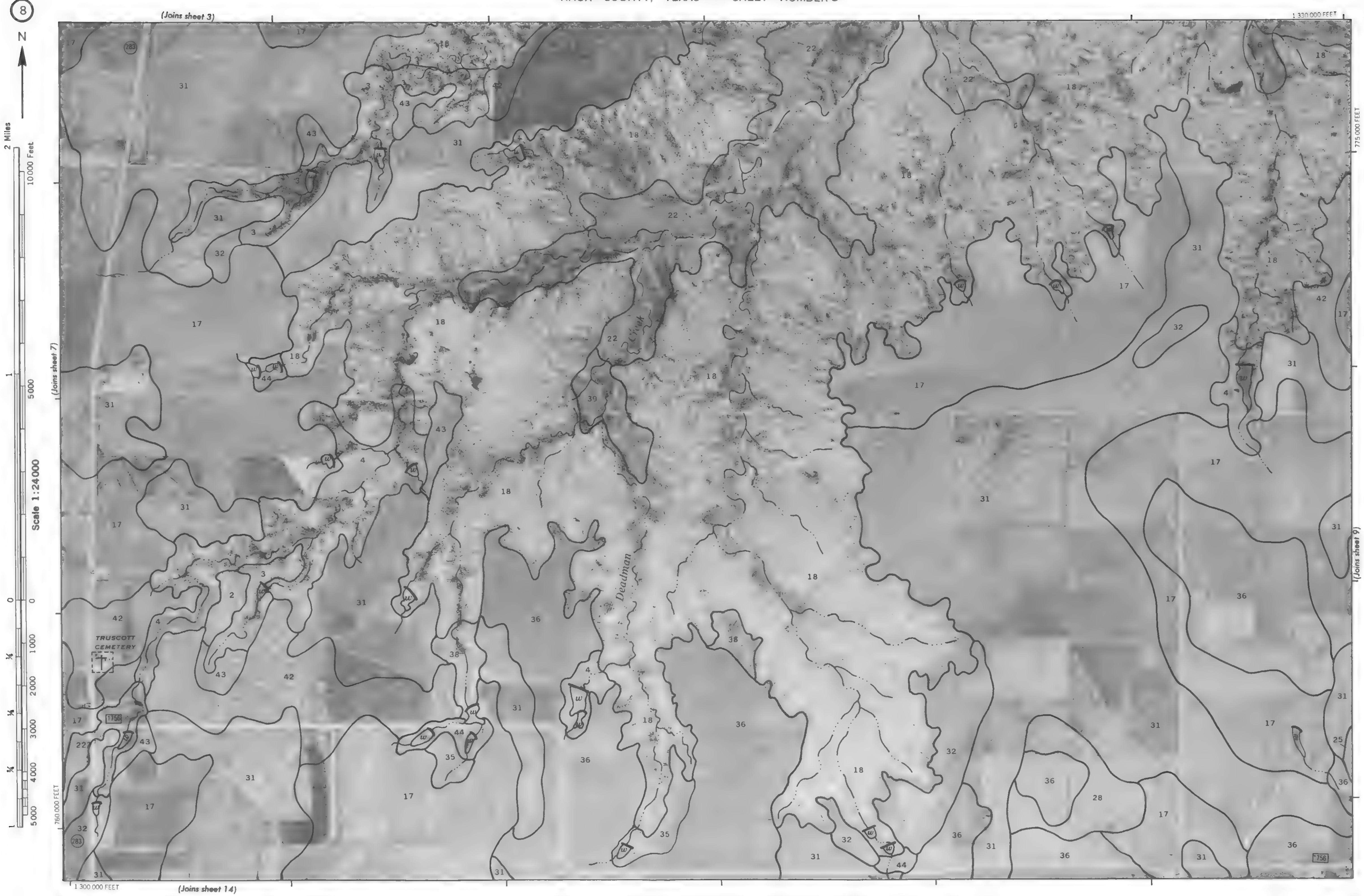
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS NO. 6

KNOX COUNTY, TEXAS NO. 7

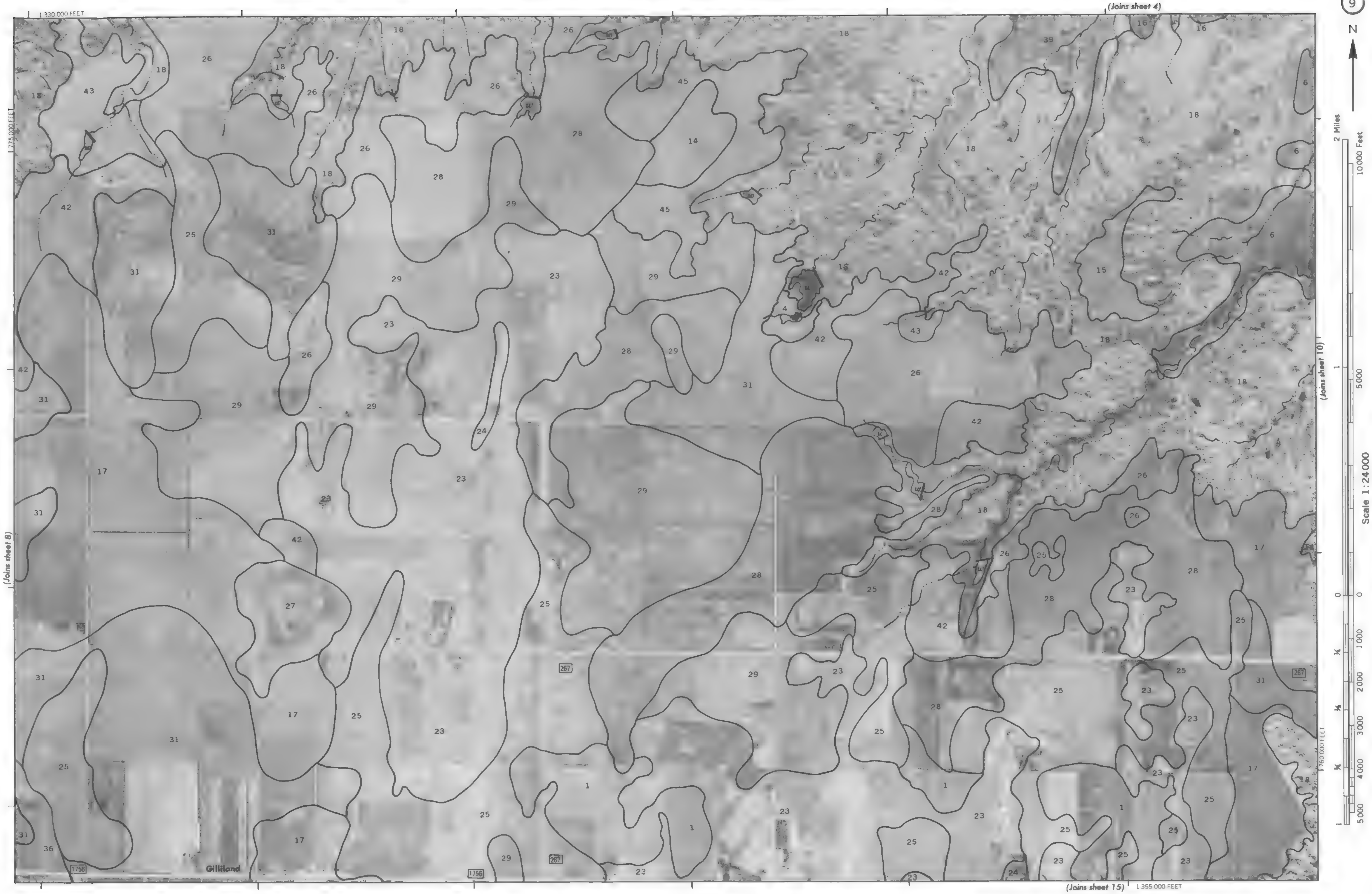
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This map is comp[illegible] 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approx[illegible]ely positioned

KNOX COUNTY, TEXAS — SHEET NUMBER 9



KNOX COUNTY, TEXAS NO. 9

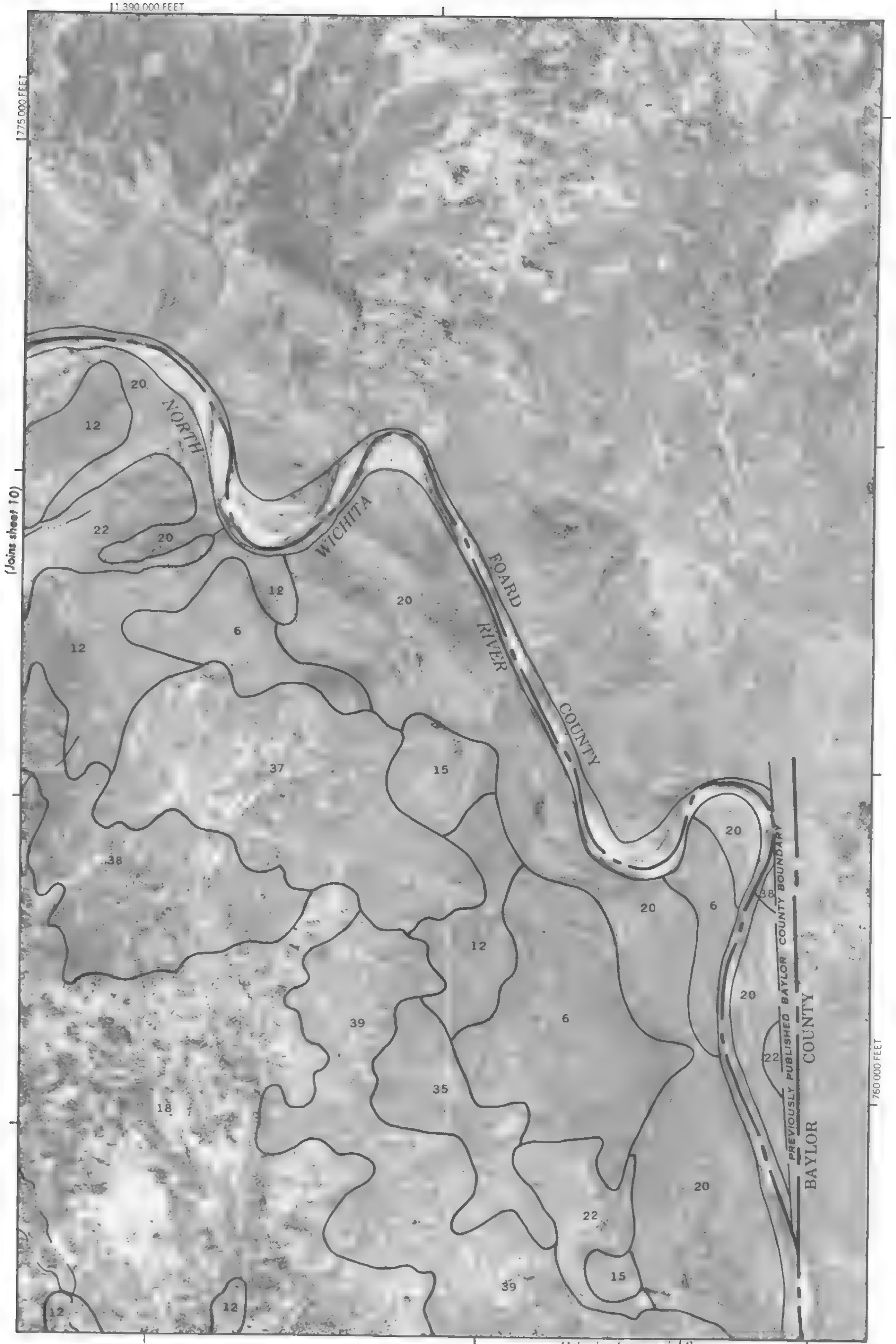
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

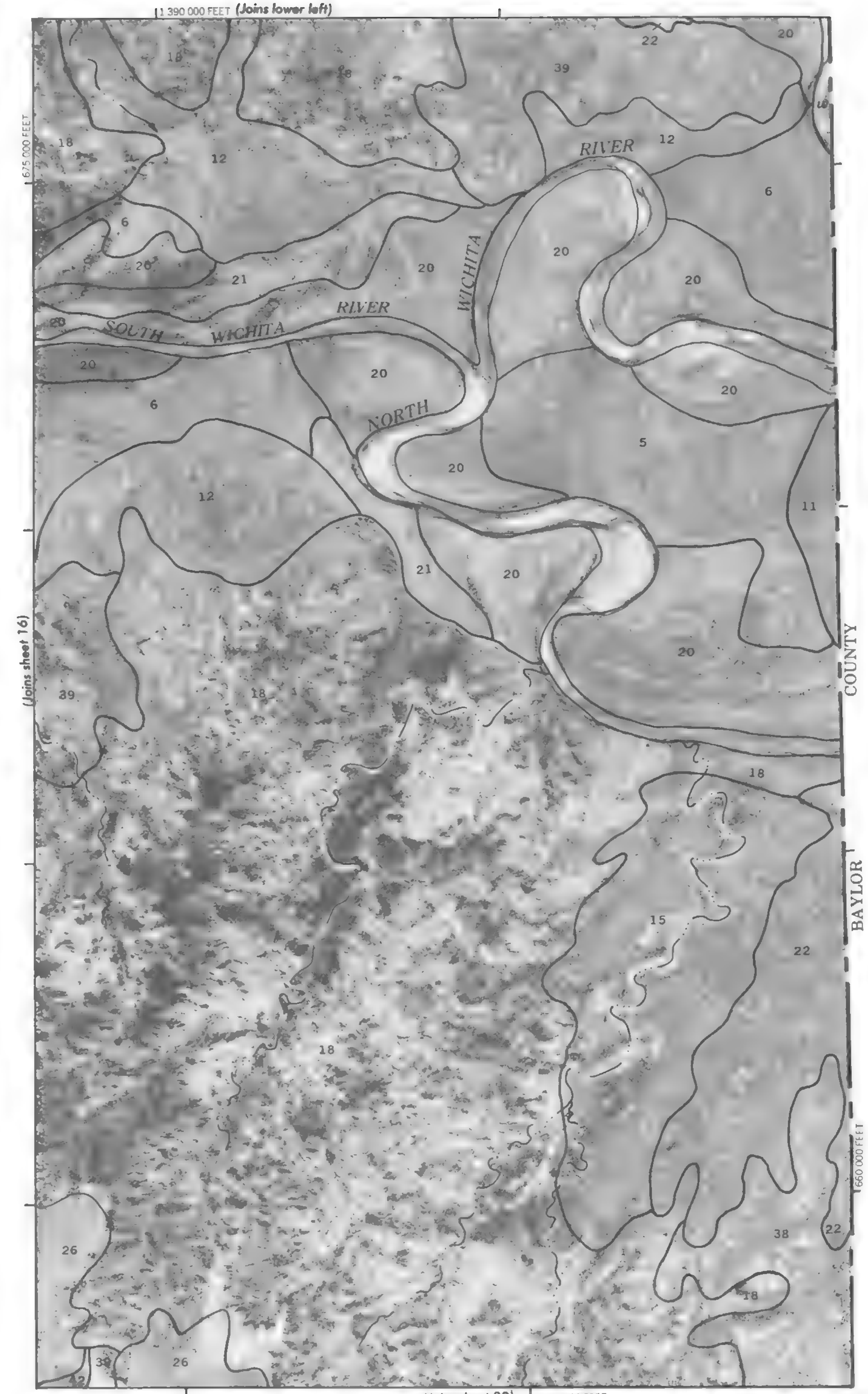
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS NO. 10

KNOX COUNTY, TEXAS NO. 11

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

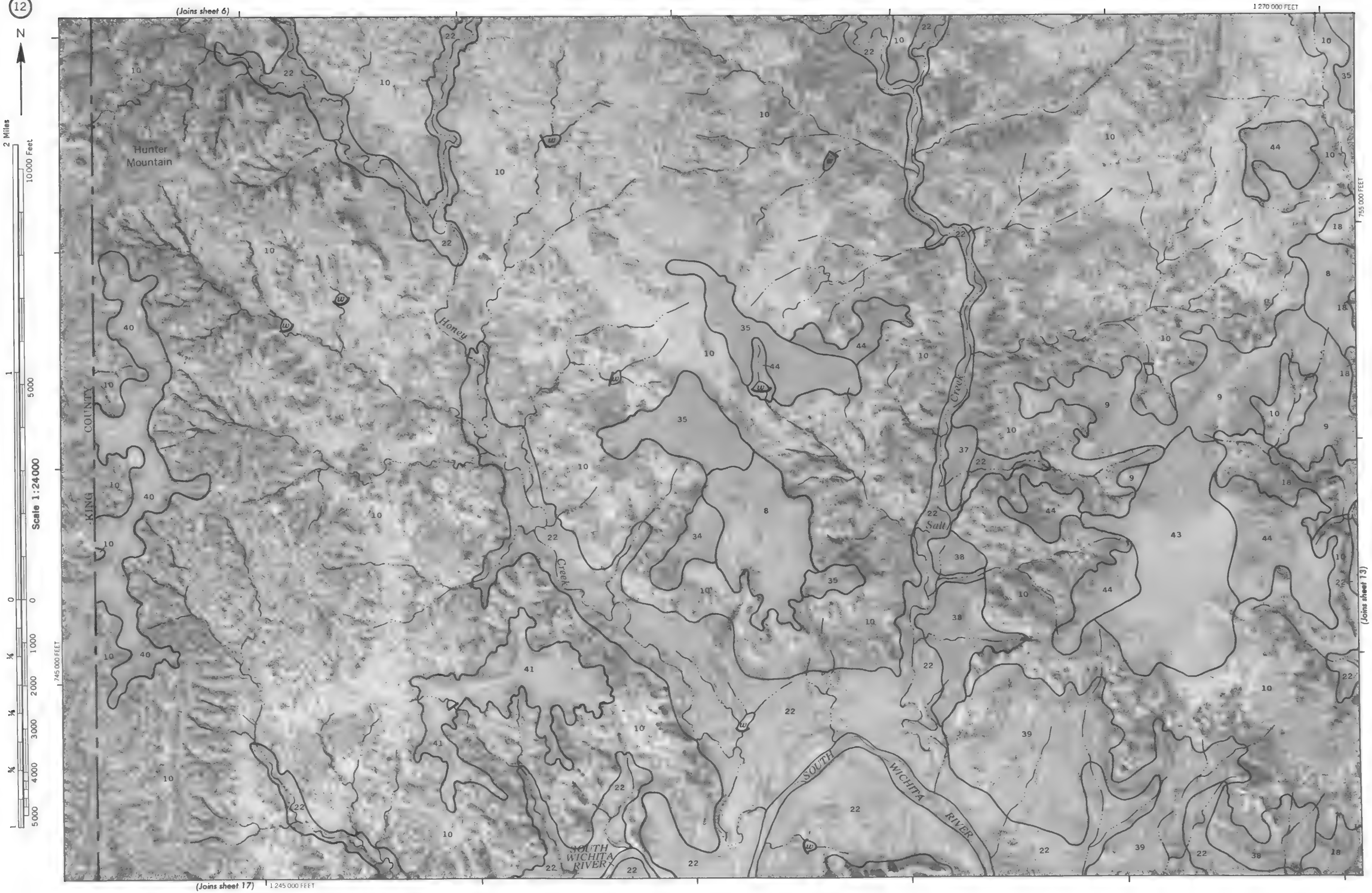




11

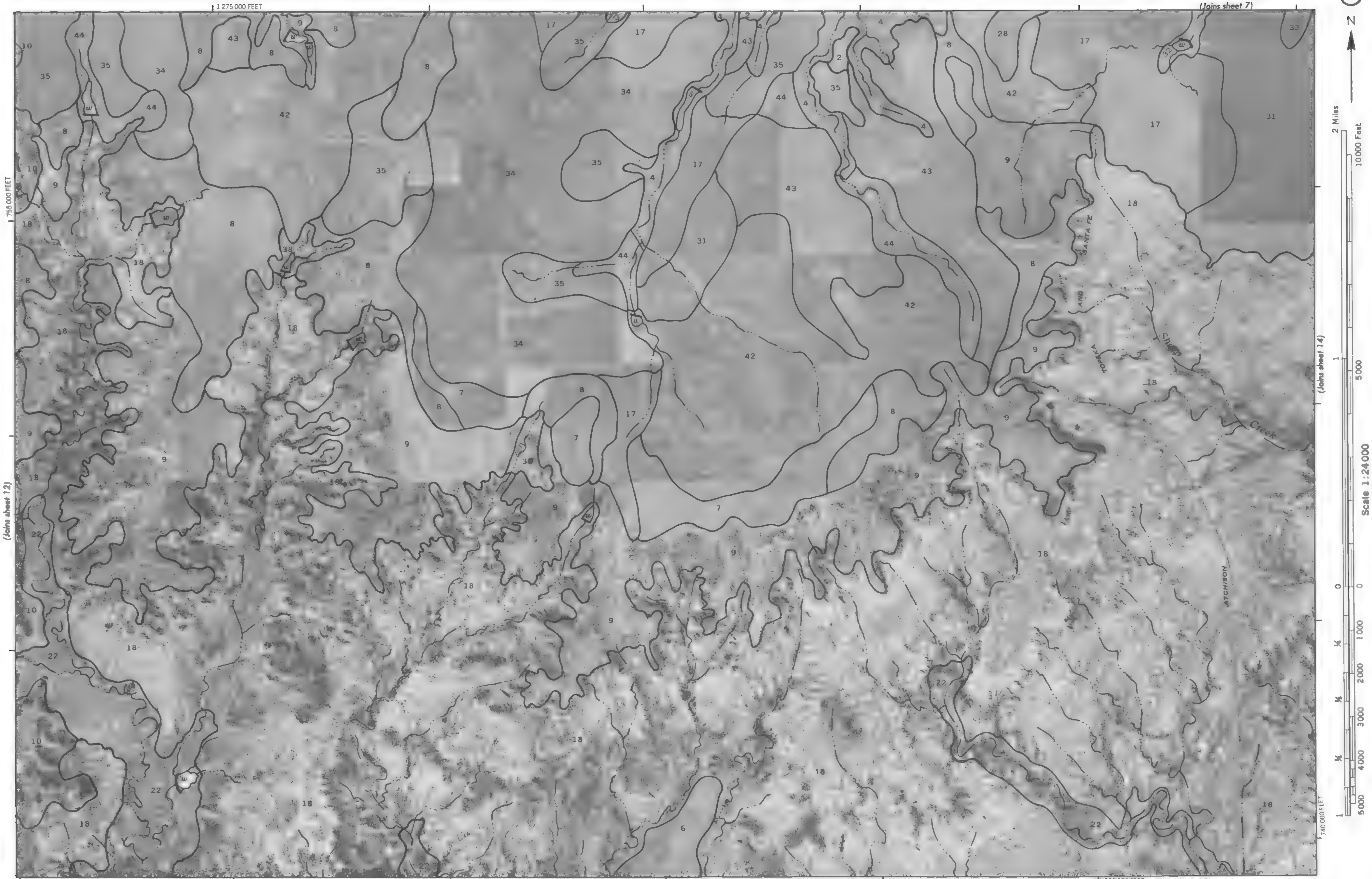
N

2 Miles
10000 Feet
1
5000
Scale 1:24000
0
1000
2000
3000
4000
5000



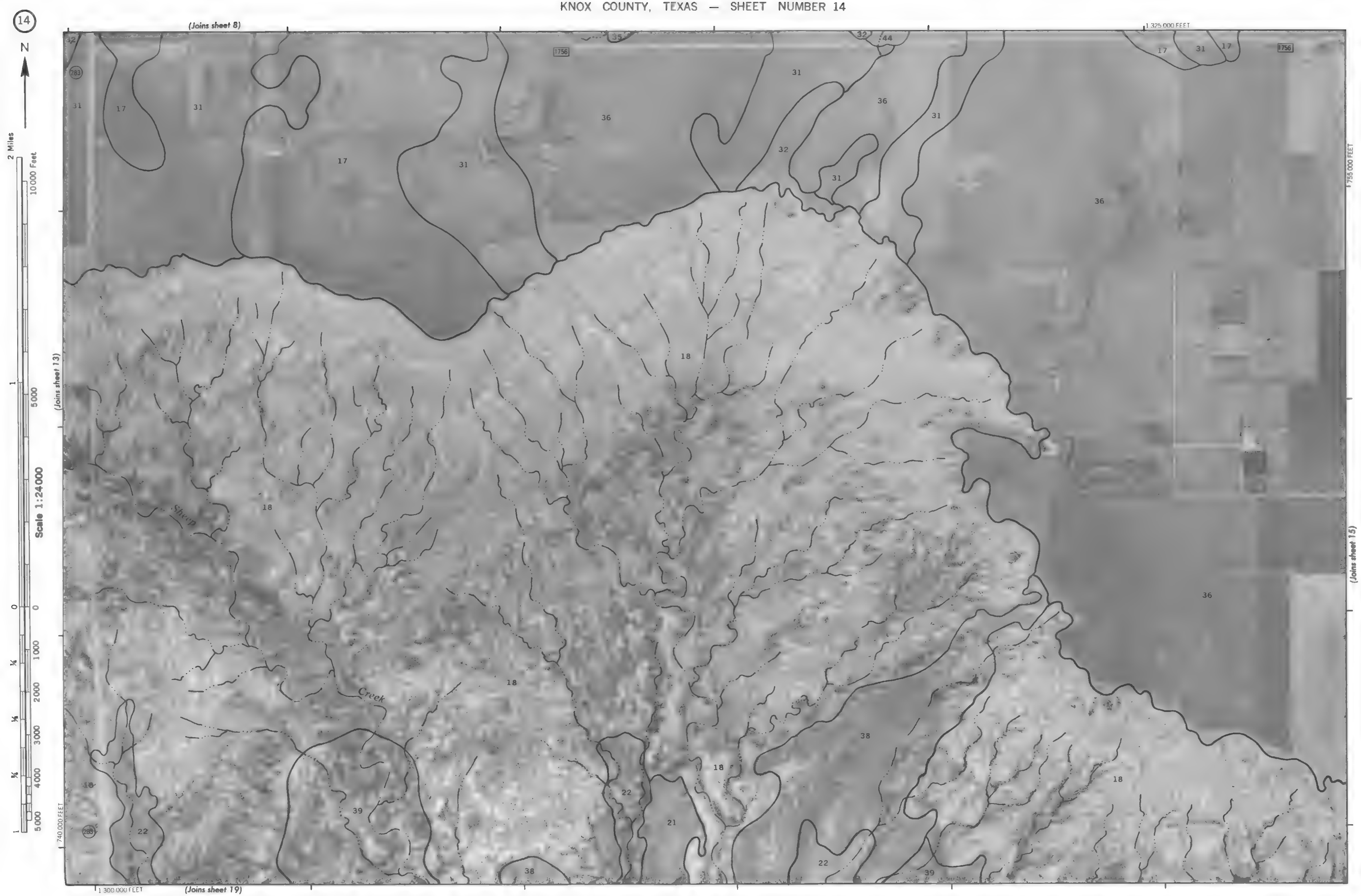
This map is [illegible] 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS NO. 12



KNOX COUNTY, TEXAS NO. 13

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

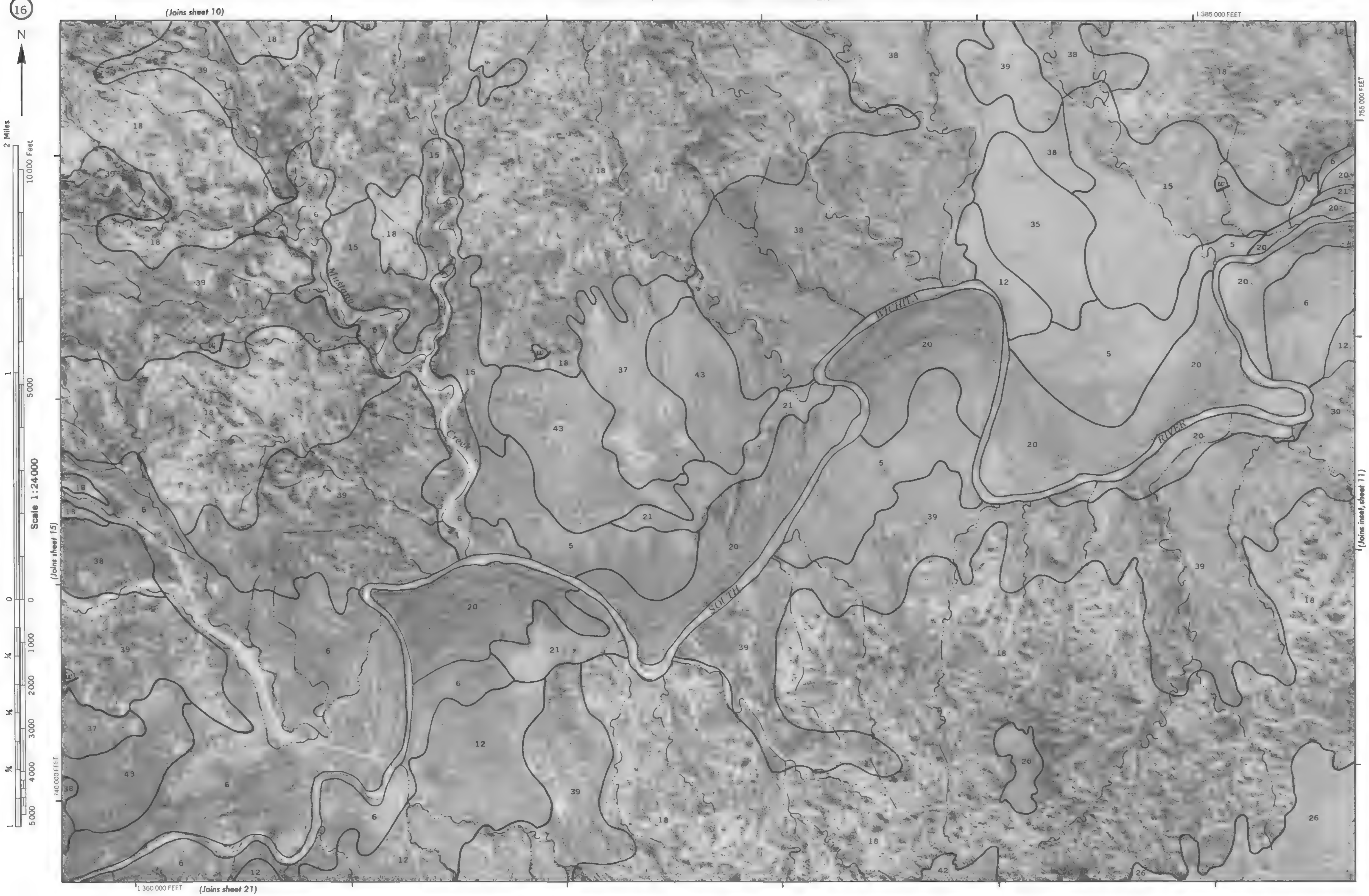


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

KNOX COUNTY, TEXAS NO. 14

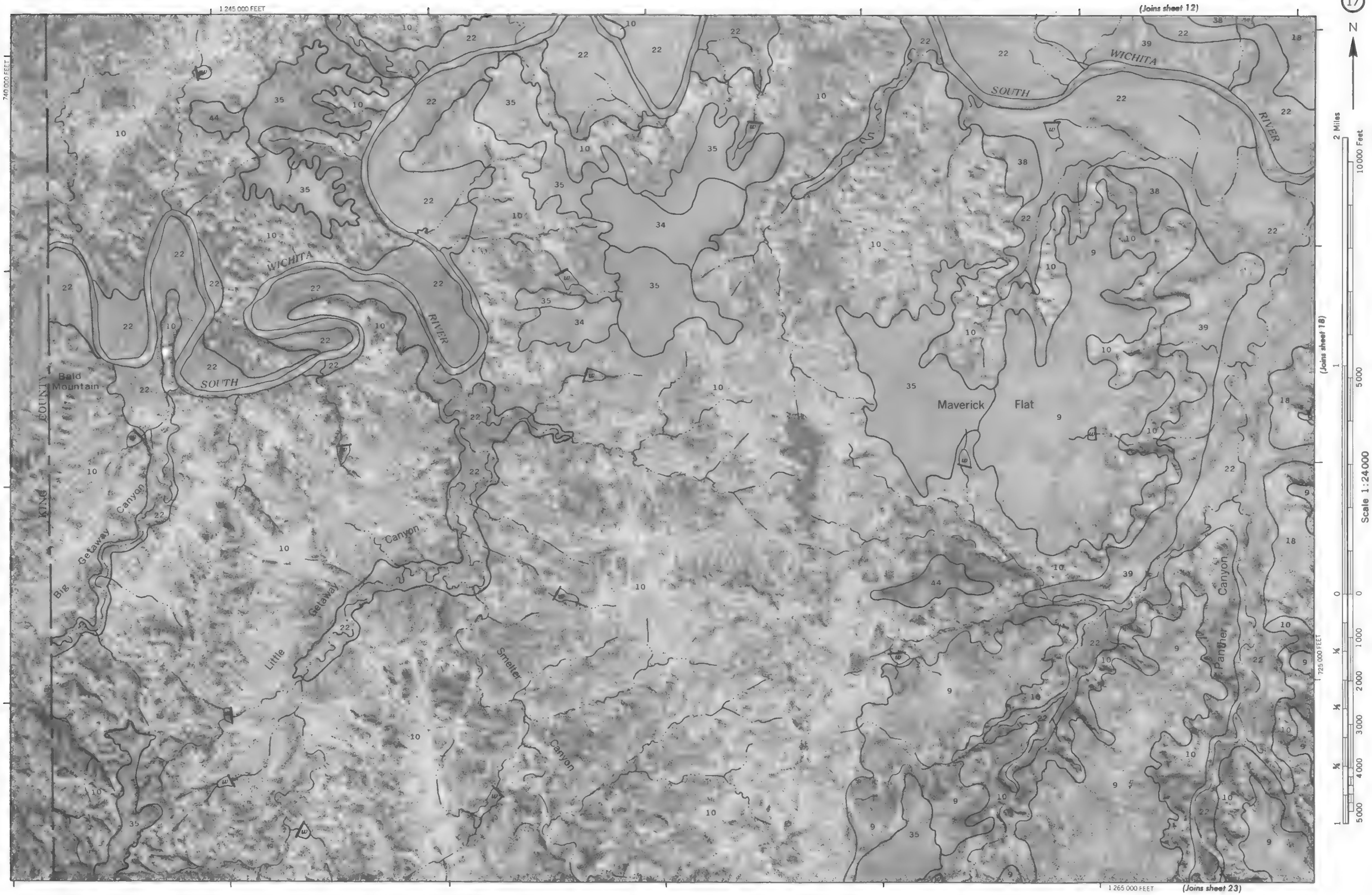
KNOX COUNTY, TEXAS NO. 15

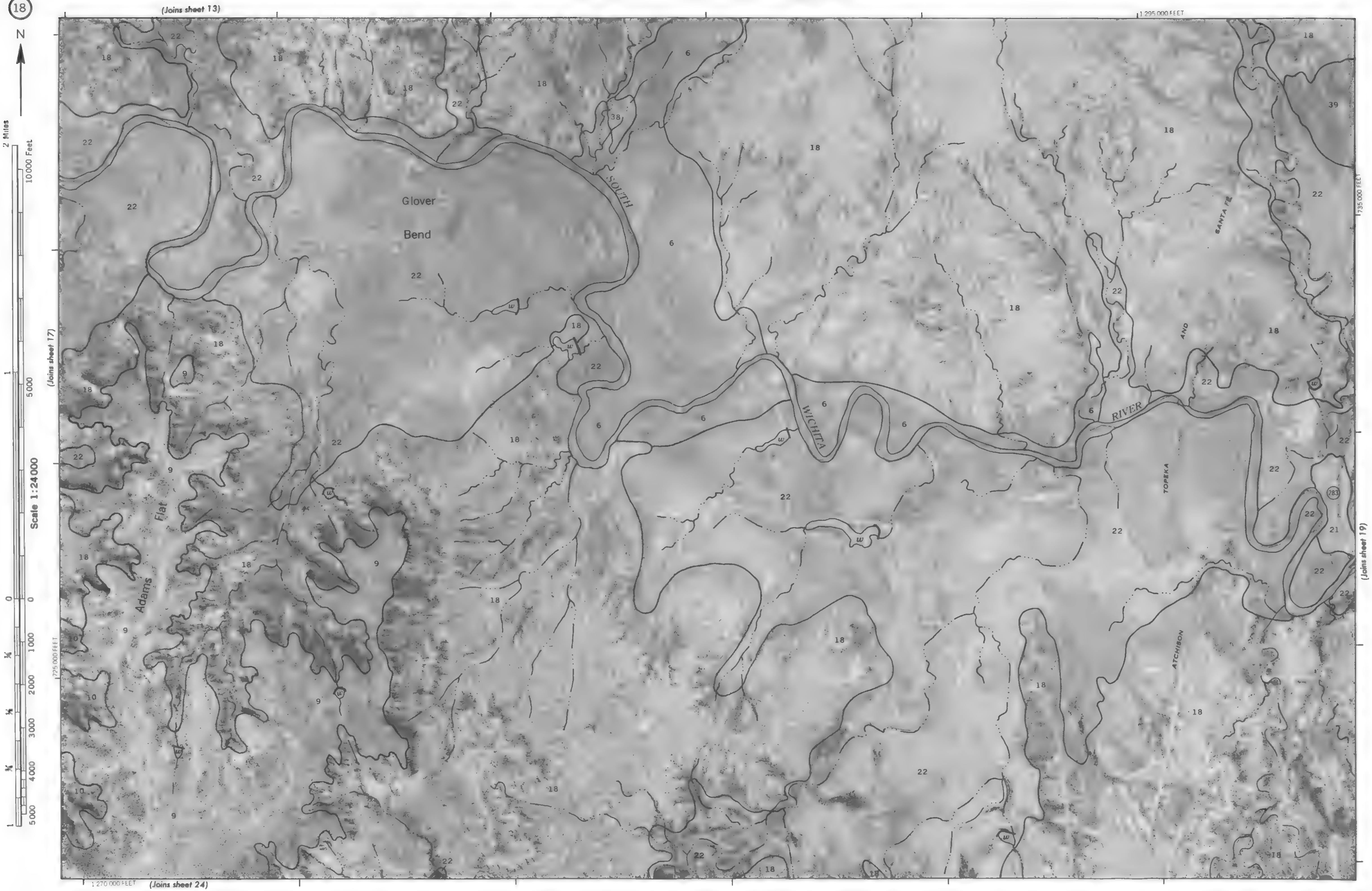
This map is compiled on [illegible] aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

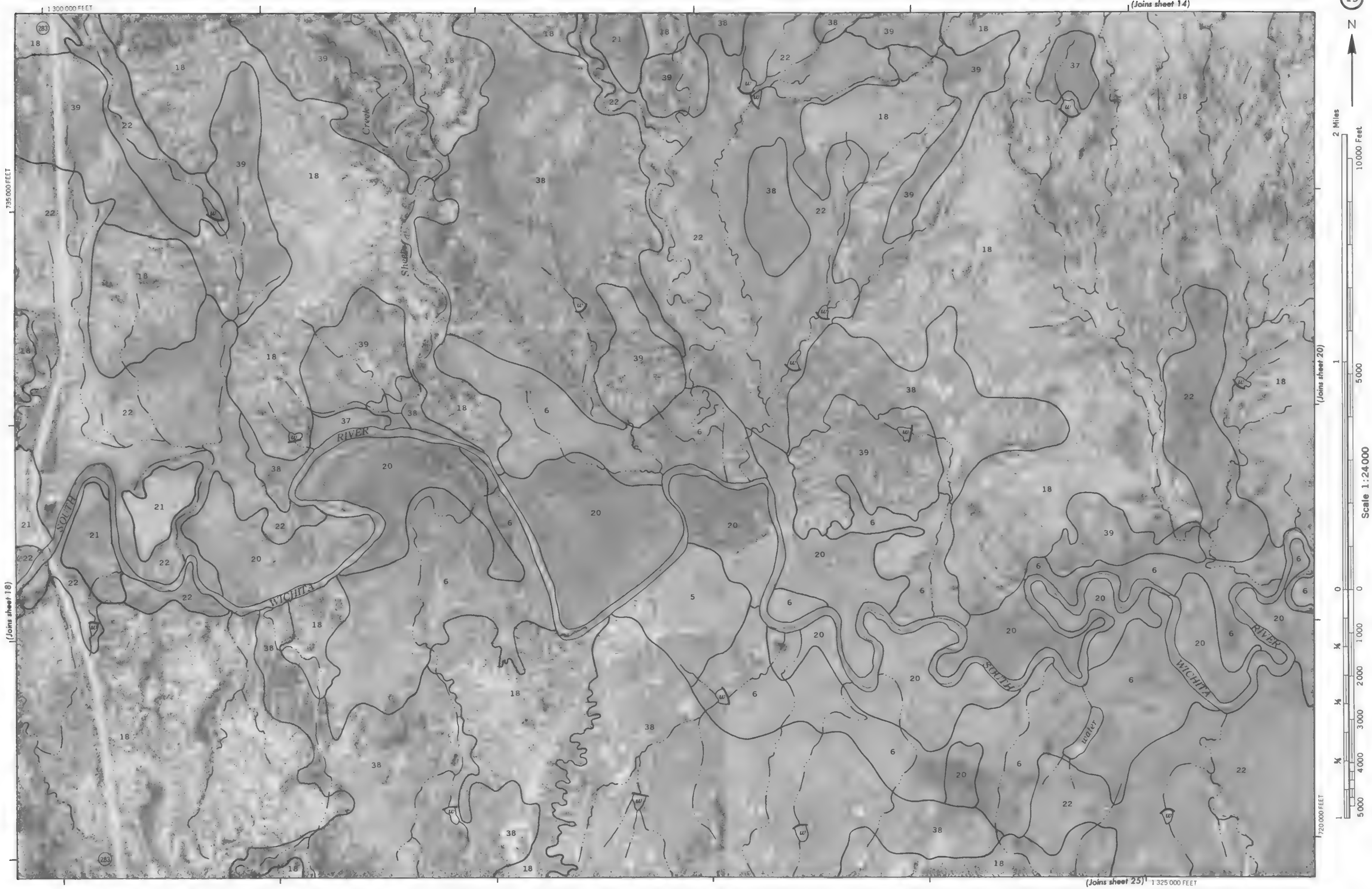


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS NO. 16


17
(Joins sheet 12)
1 245 000 FEET
740 000 FEET
KNOX COUNTY, TEXAS NO. 17
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.
N
SOUTH
WICHITA
RIVER
Bald Mountain
KING COUNTY
Big Getaway Canyon
Little Getaway Canyon
Smelter Canyon
Maverick Flat
Panther Canyon
(Joins sheet 18)
725 000 FEET
1 265 000 FEET
(Joins sheet 23)
2 Miles
10000 Feet
Scale 1:24000

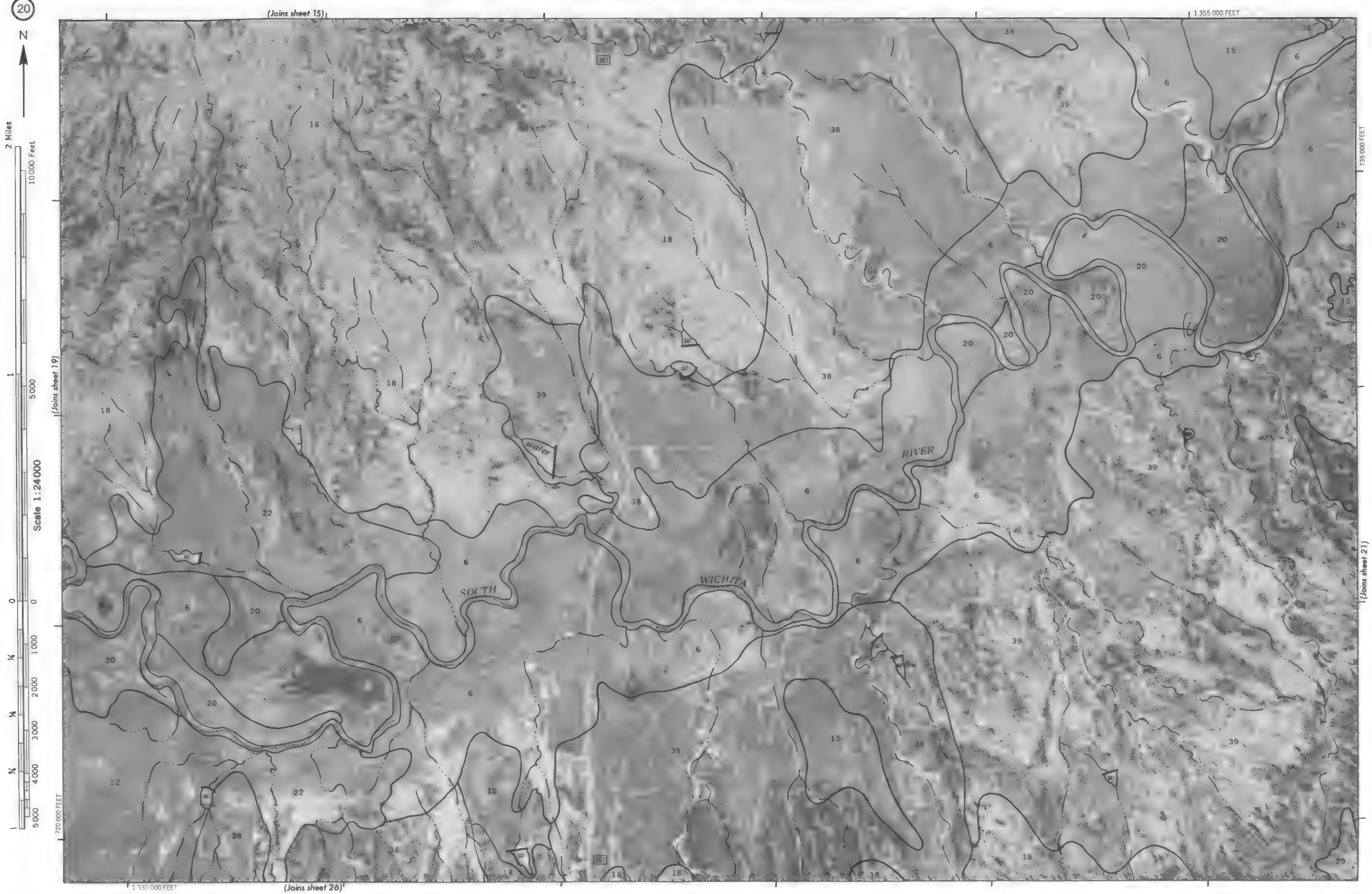

18
N
(Joins sheet 13)
(Joins sheet 17)
(Joins sheet 19)
(Joins sheet 24)
1 295 000 FEET
735 000 FEET
725 000 FEET
1 270 000 FEET
Glover
Bend
SOUTH
WICHITA
RIVER
Adams
Flat
ATCHISON
TOPEKA
AND
SANTA FE
283
2 Miles
10 000 Feet
1
5000
Scale 1:24 000
0
0
1000
2000
3000
4000
5000



KNOX COUNTY, TEXAS NO. 19

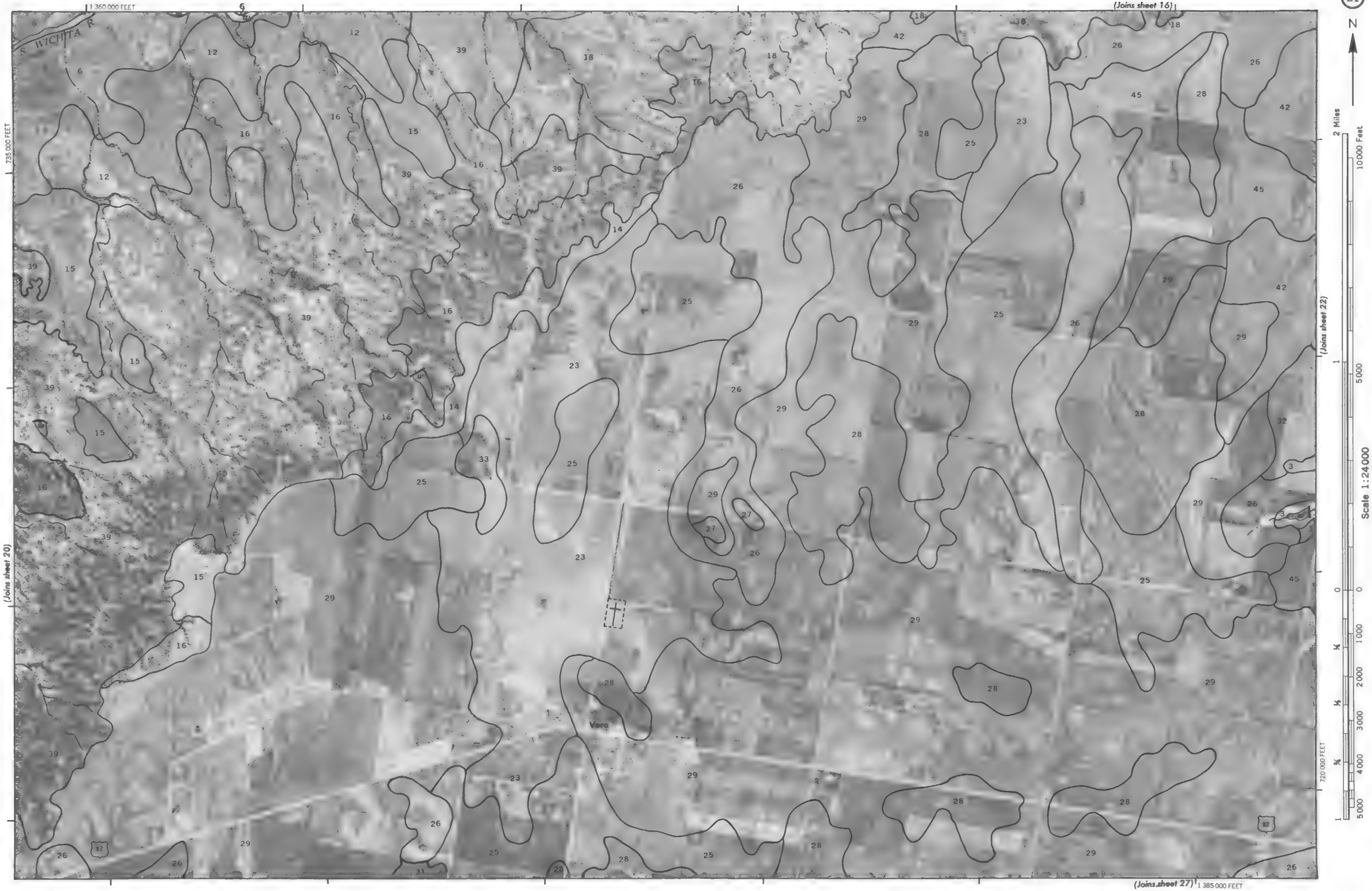
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS — SHEET NUMBER 20



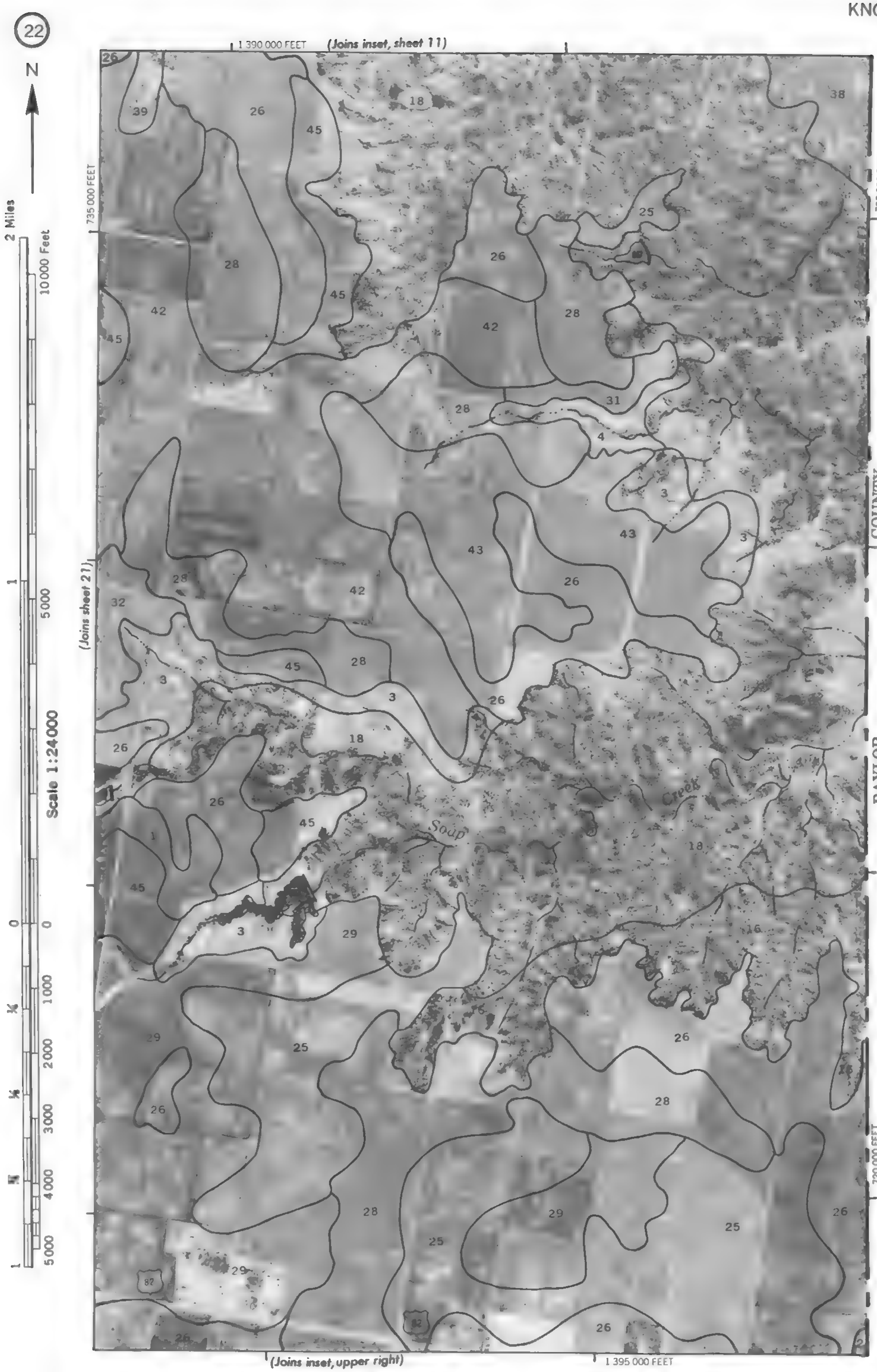
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

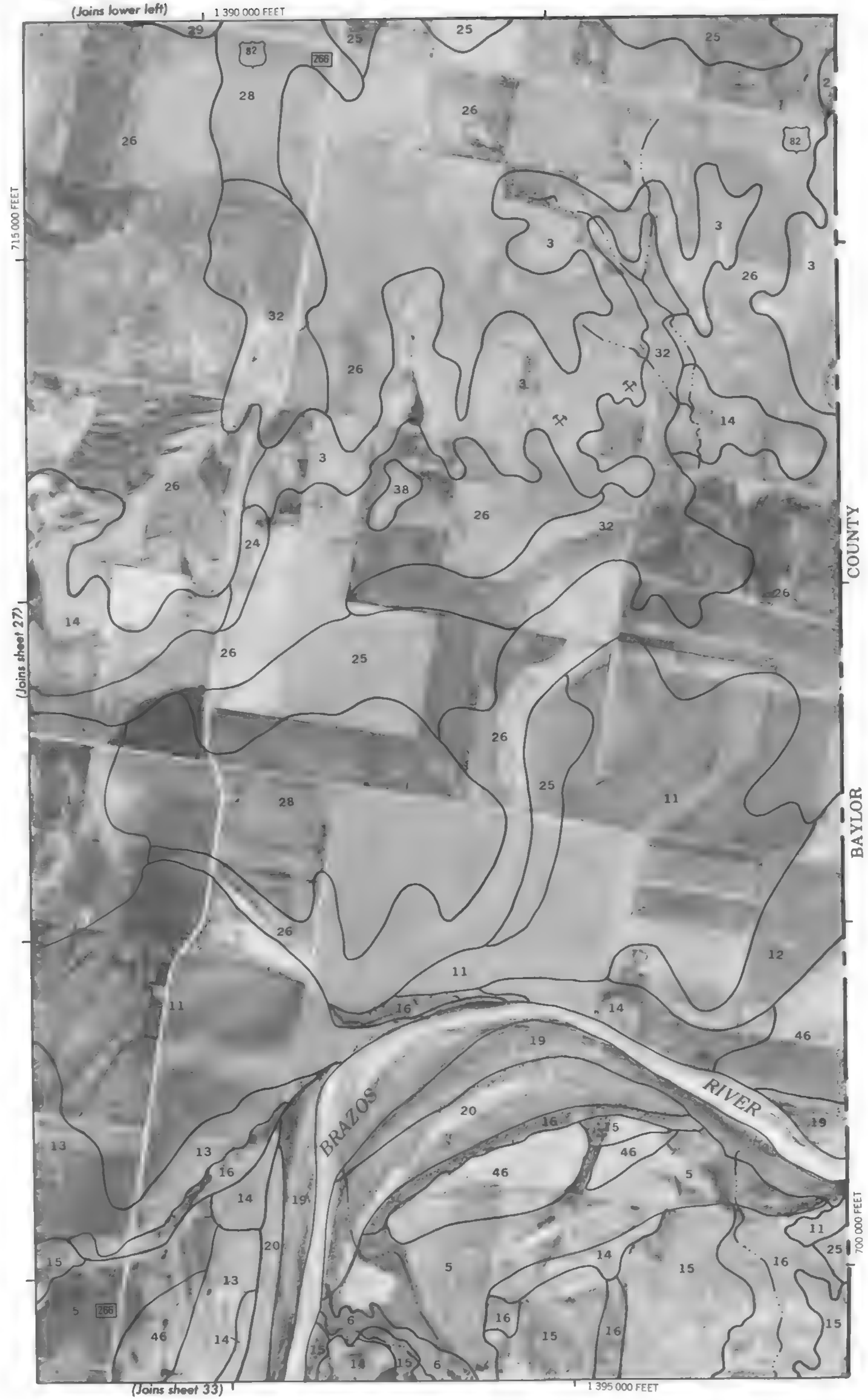
KNOX COUNTY, TEXAS NO. 20



KNOX COUNTY, TEXAS NO. 21

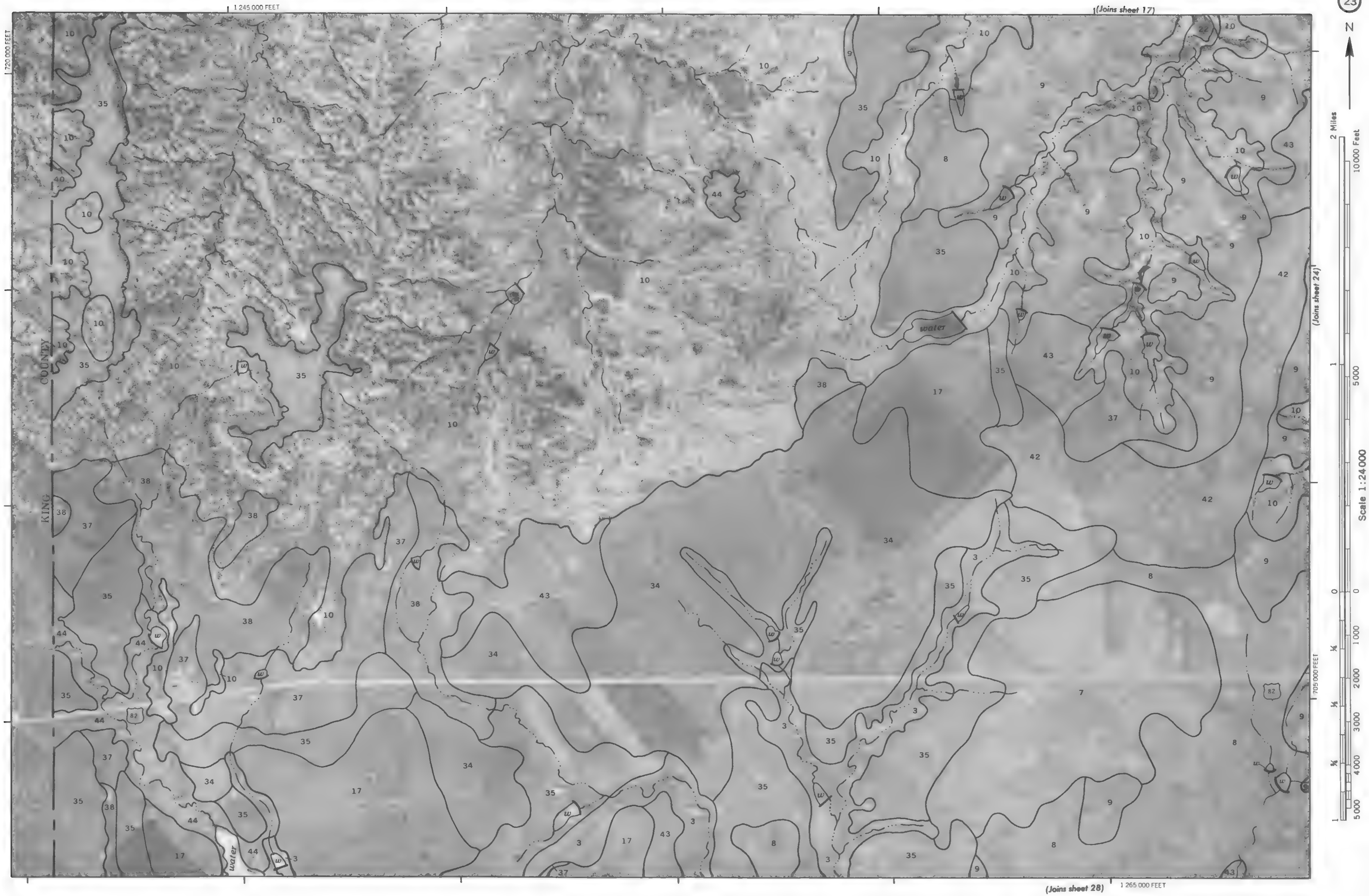
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





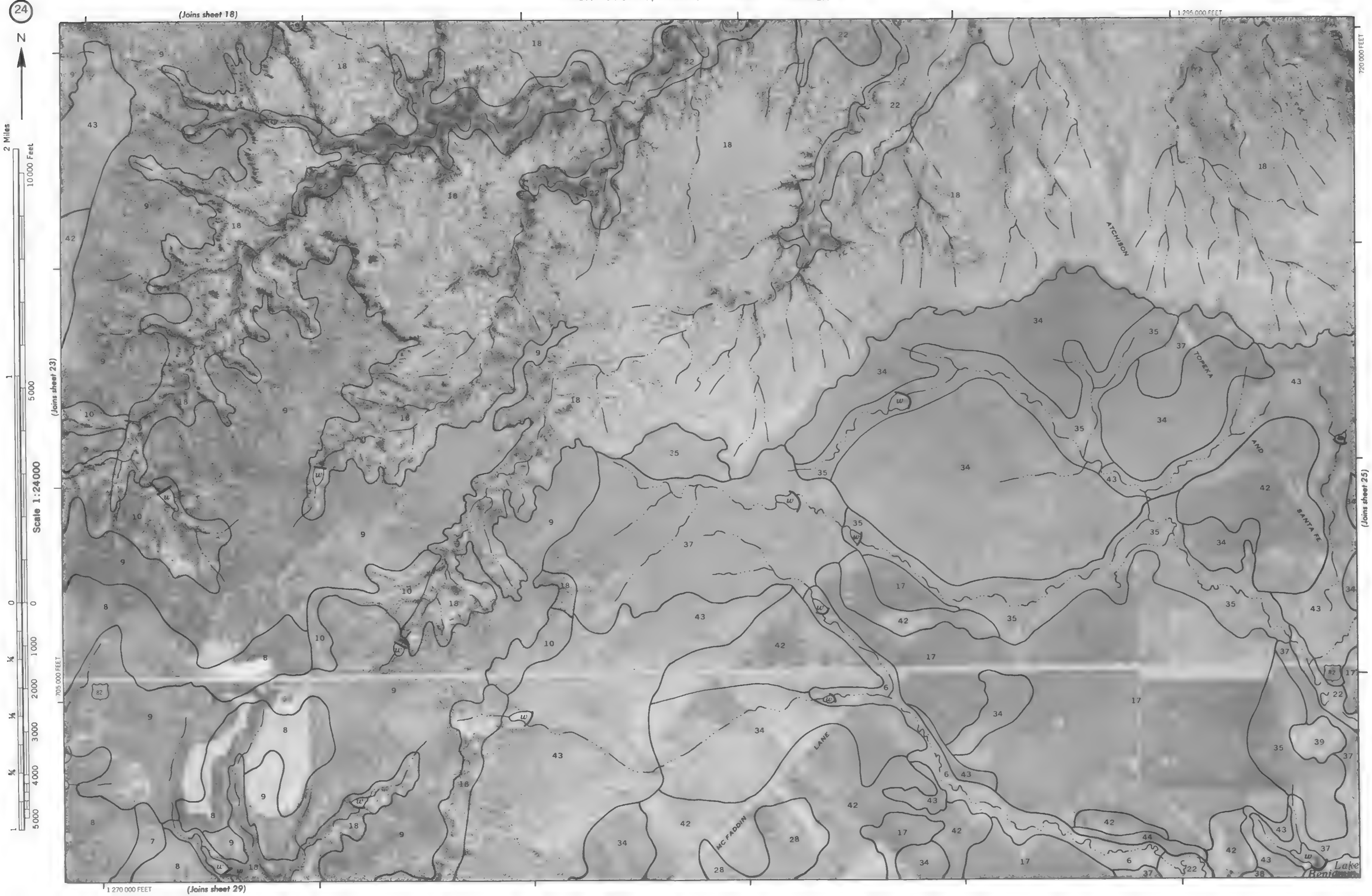
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS NO. 22



KNOX COUNTY, TEXAS NO. 23

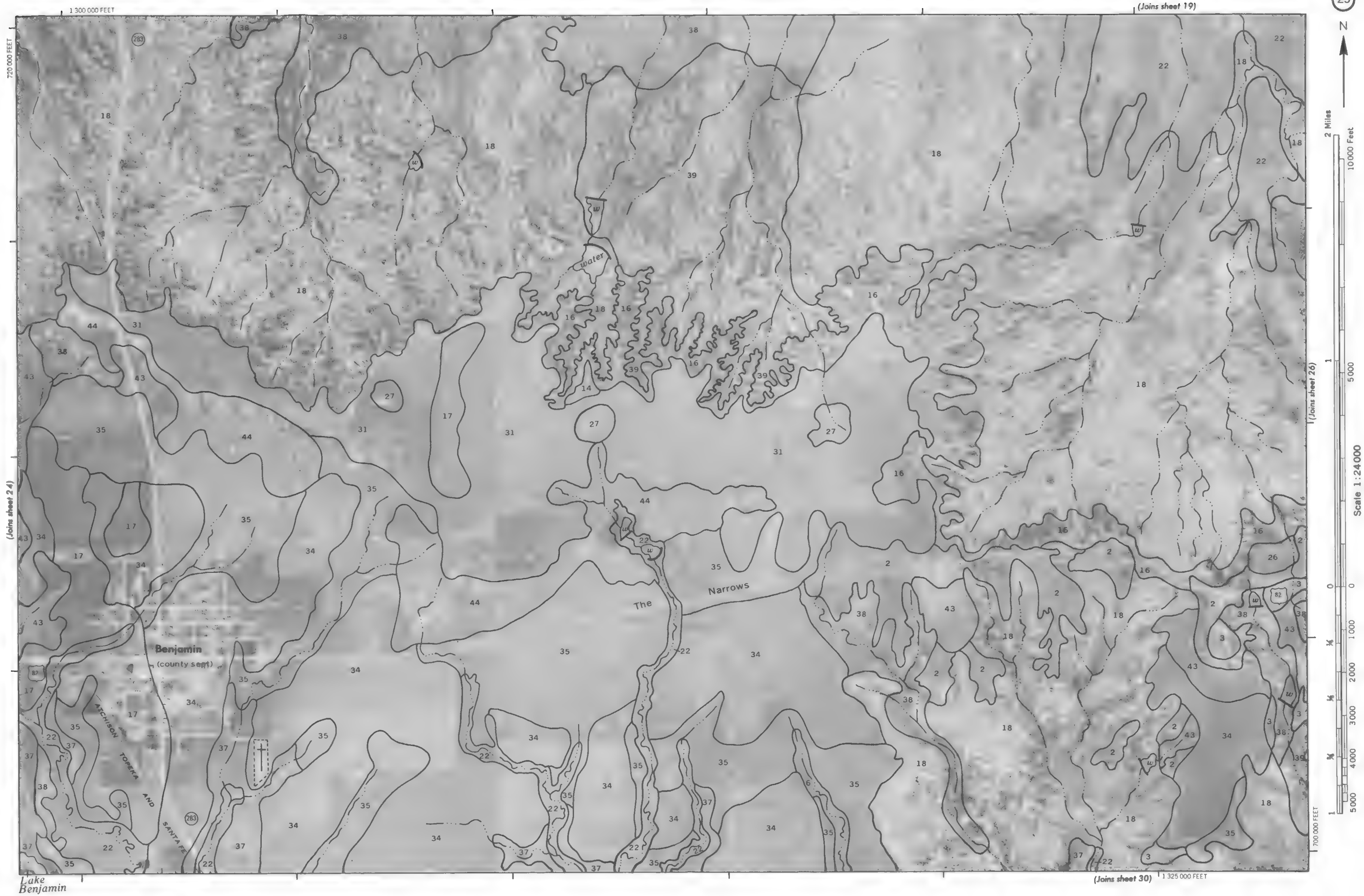
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



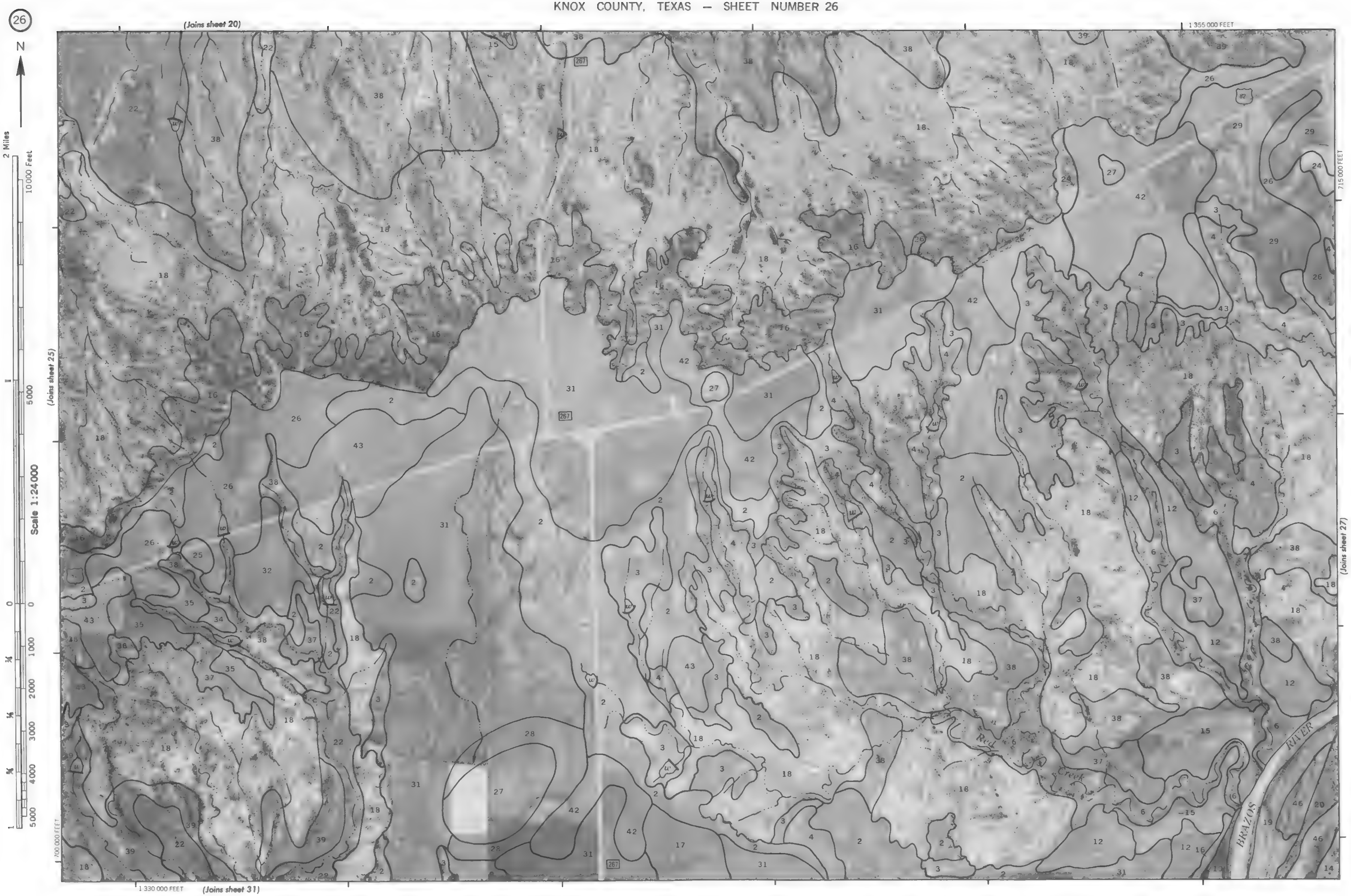
KNOX COUNTY, TEXAS NO. 24

KNOX COUNTY, TEXAS NO. 25

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



KNOX COUNTY, TEXAS — SHEET NUMBER 26



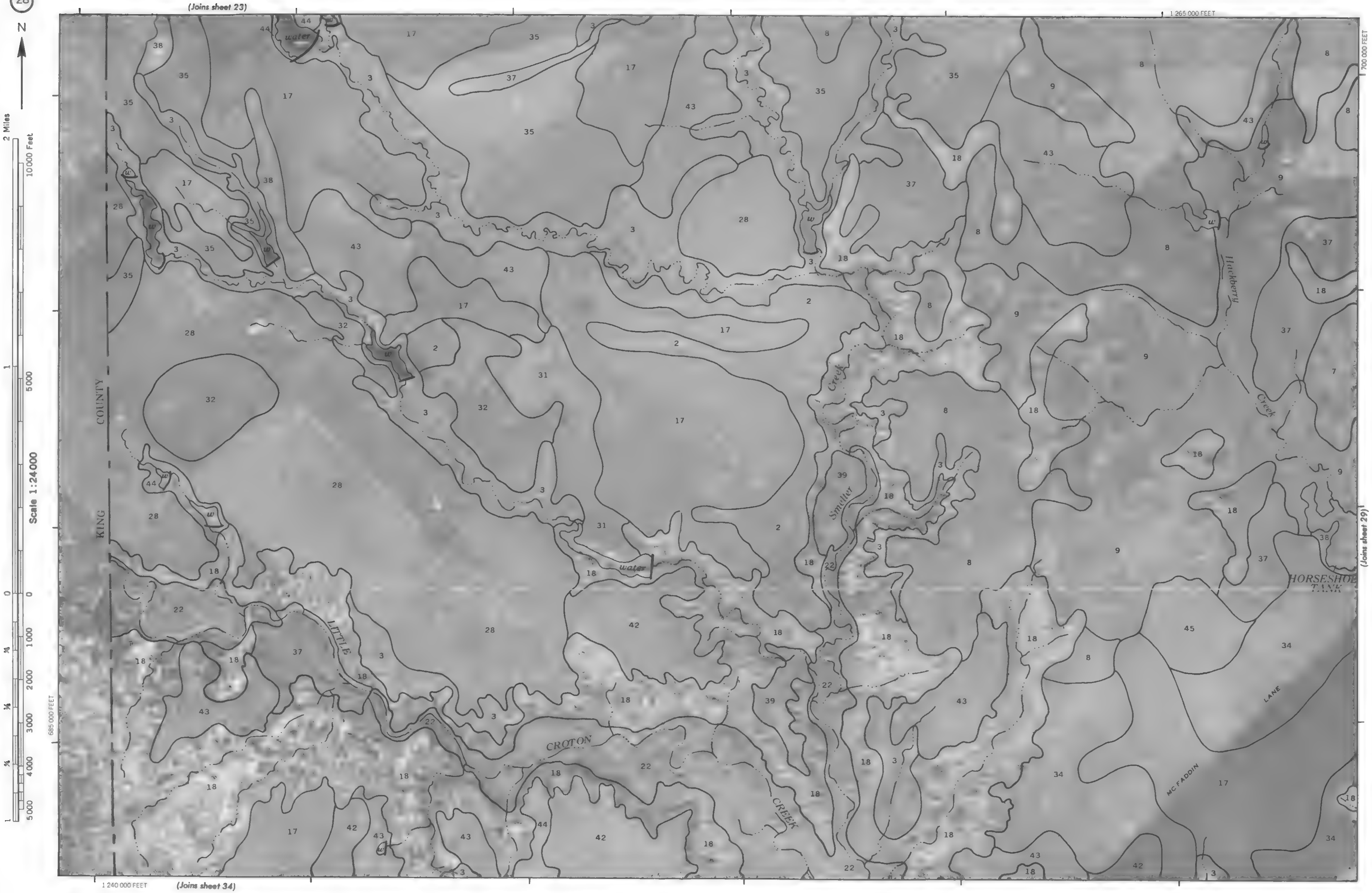
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS NO. 26

KNOX COUNTY, TEXAS NO. 27

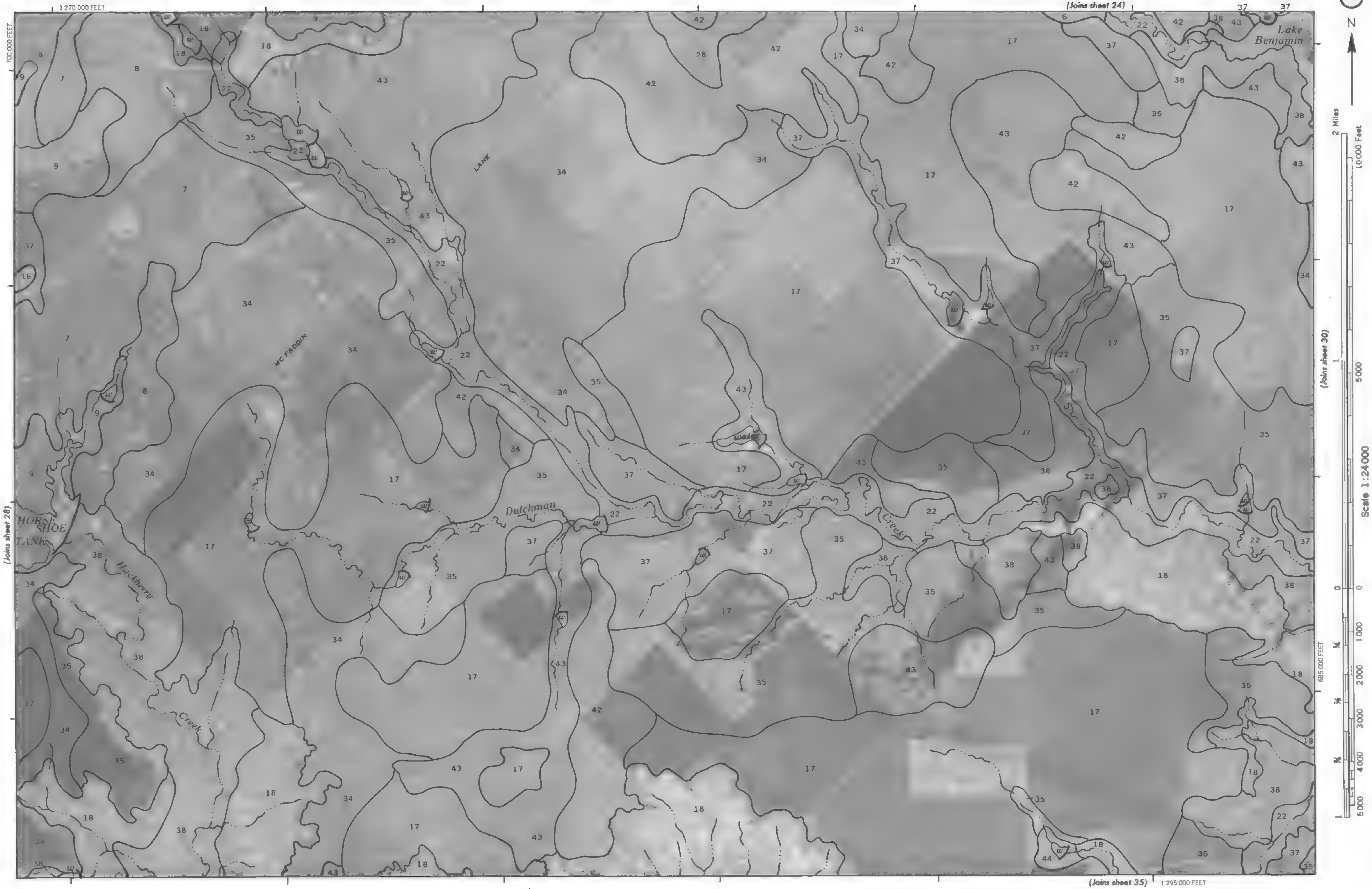
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS — SHEET NUMBER 28



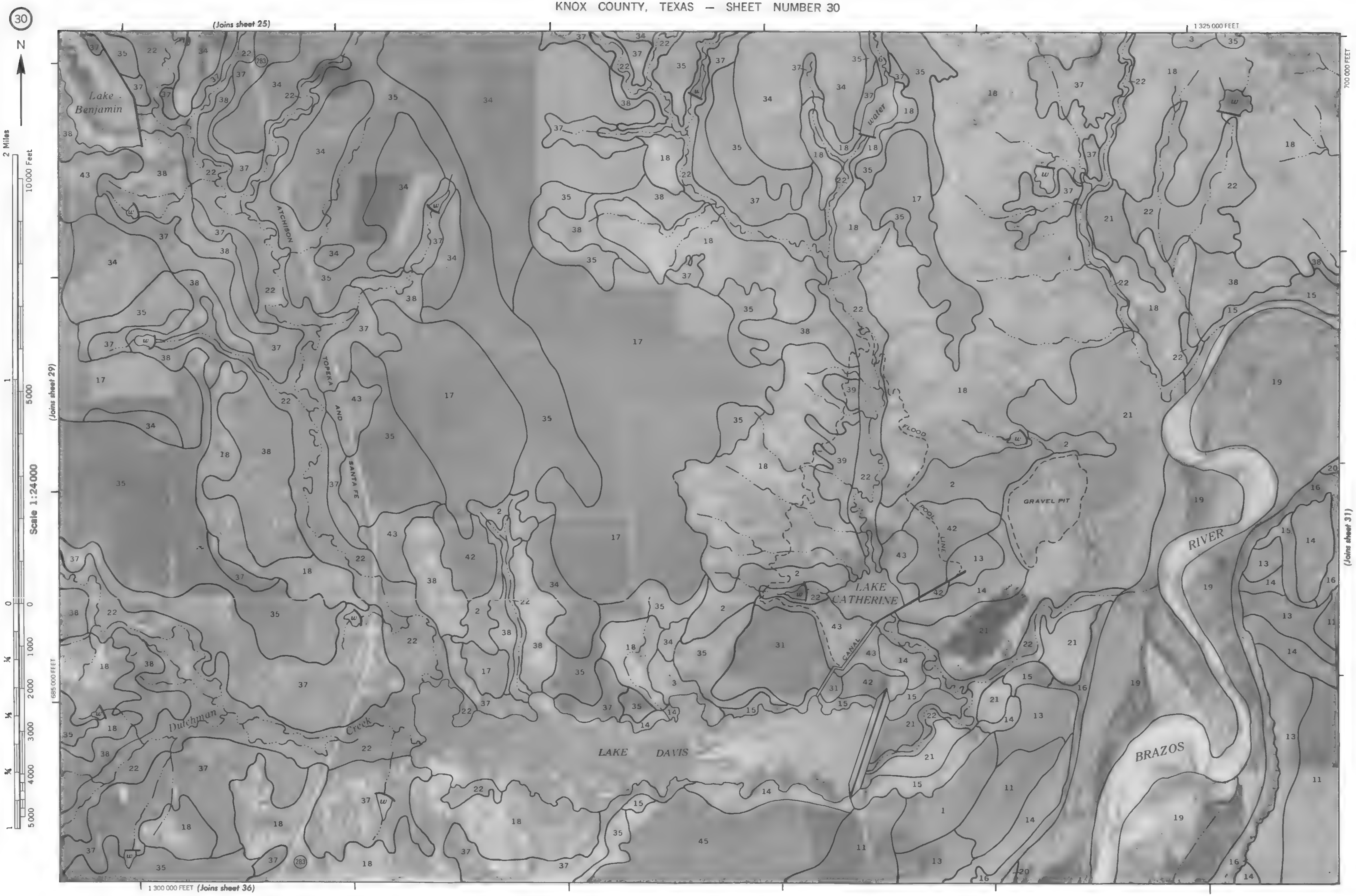
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS NO. 28



KNOX COUNTY, TEXAS NO. 29

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

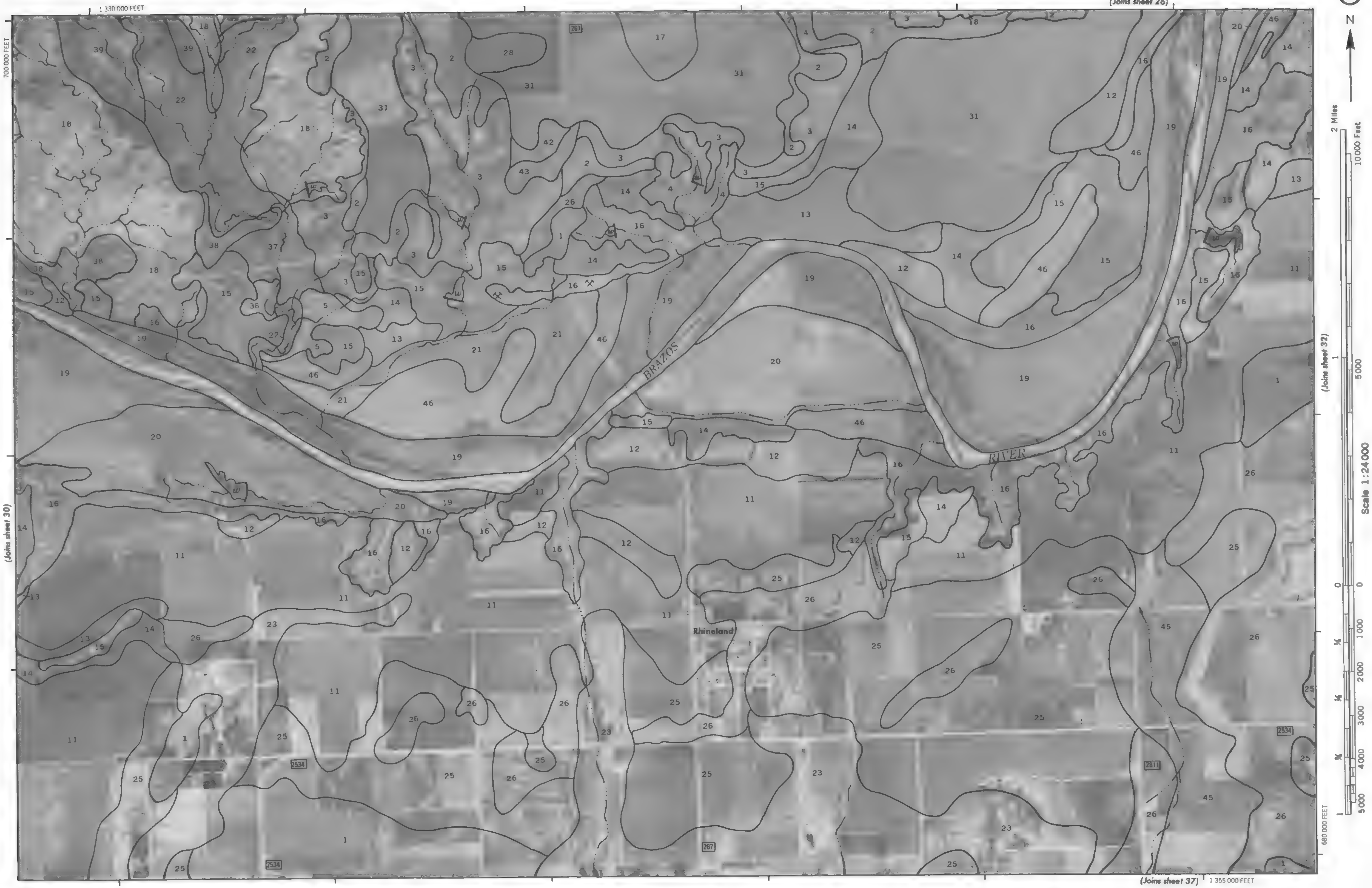


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS NO. 30

KNOX COUNTY, TEXAS NO. 31

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



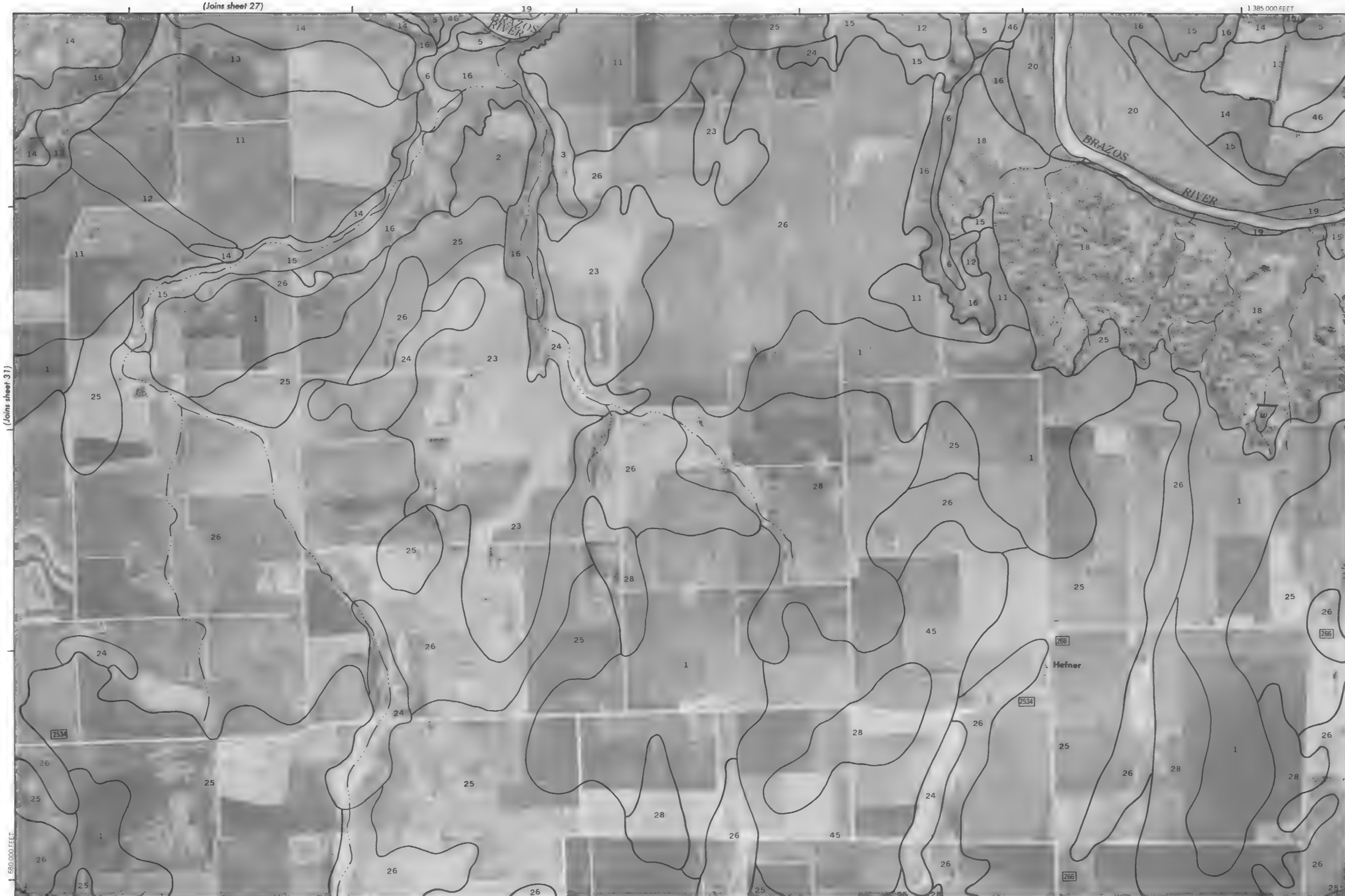
32

N

2 Miles

10 000 Feet

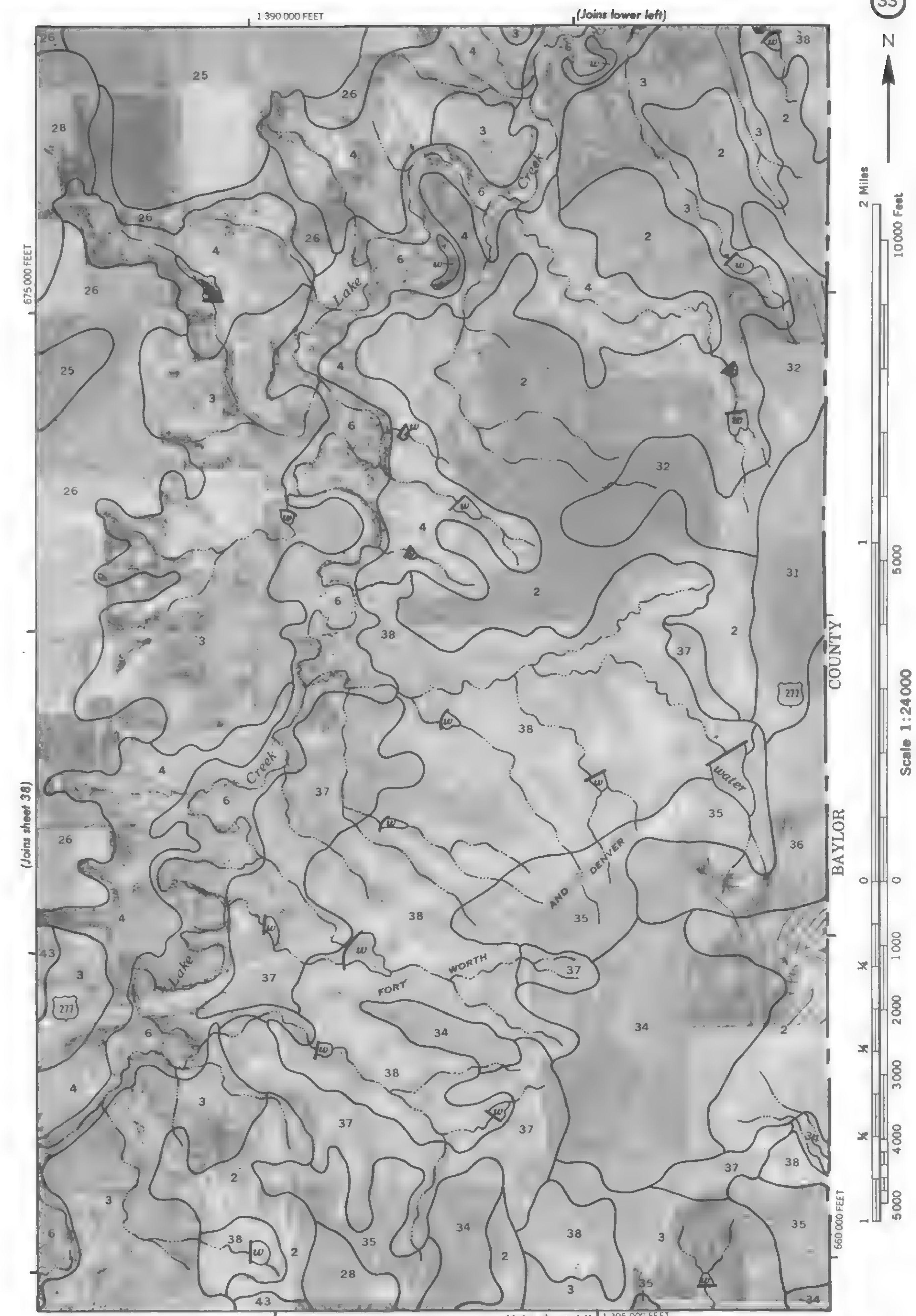
Scale 1:24 000

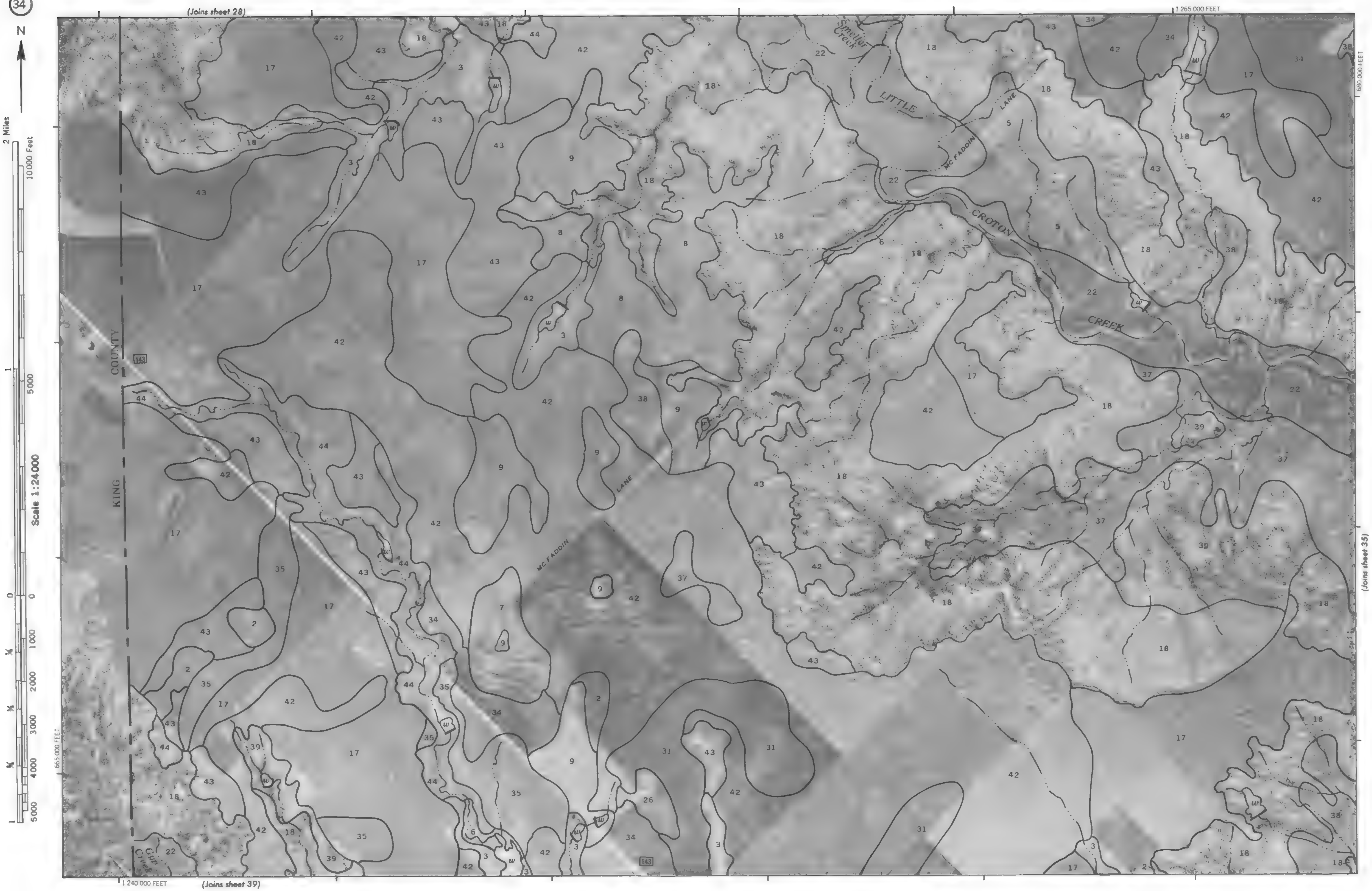


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS NO. 33

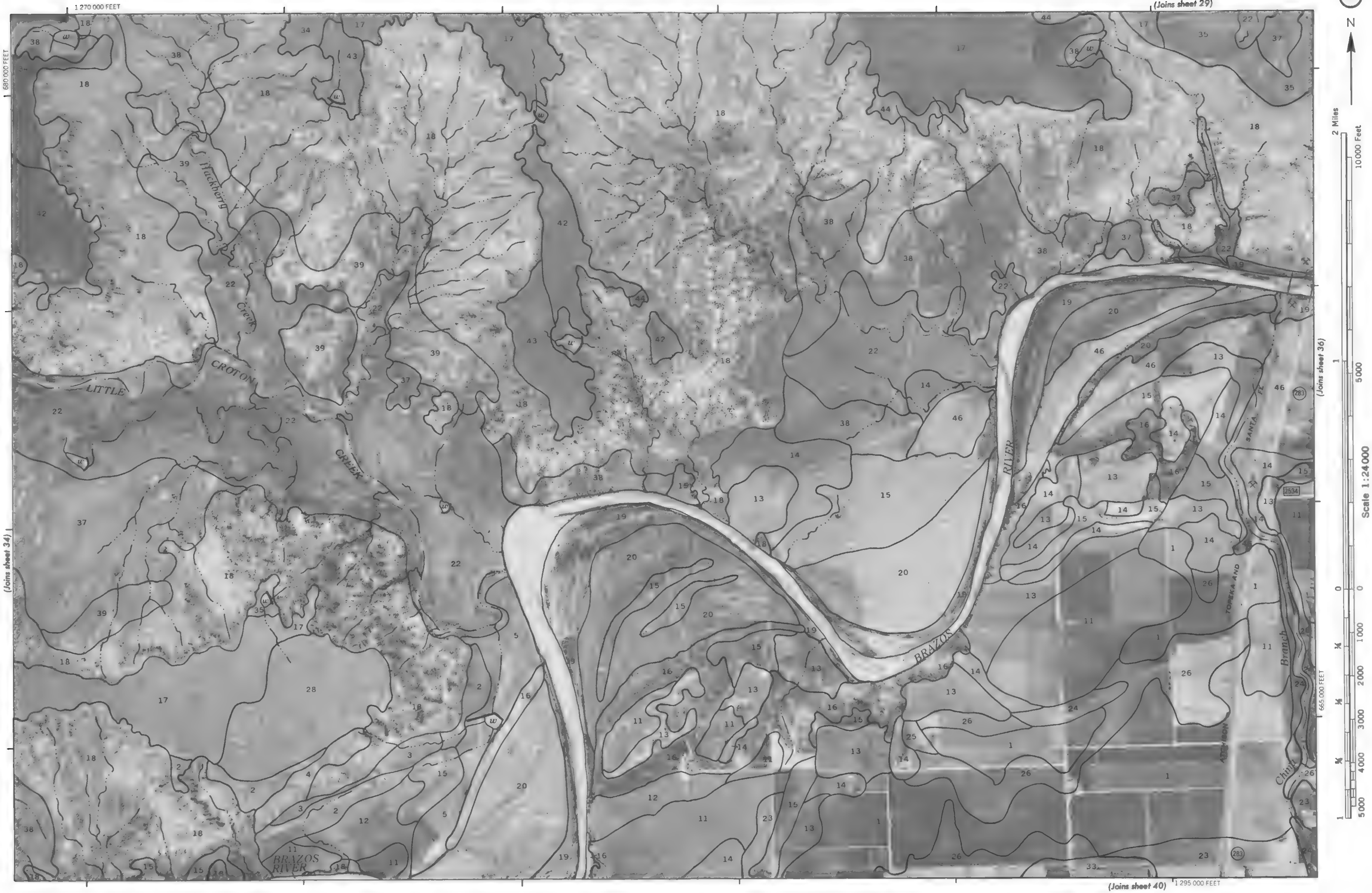
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS NO. 34



KNOX COUNTY, TEXAS NO. 35

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

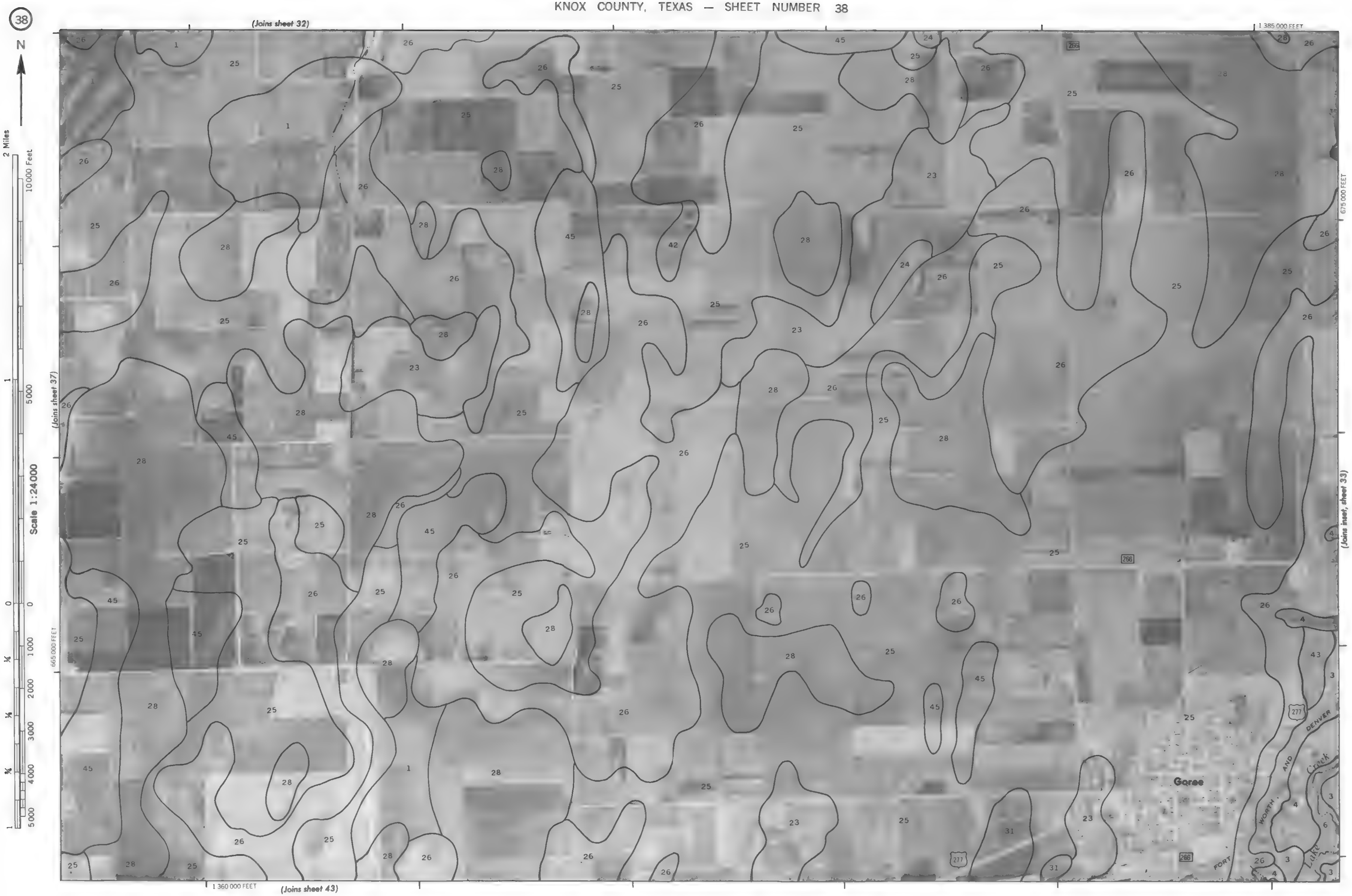
KNOX COUNTY, TEXAS — SHEET NUMBER 36

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

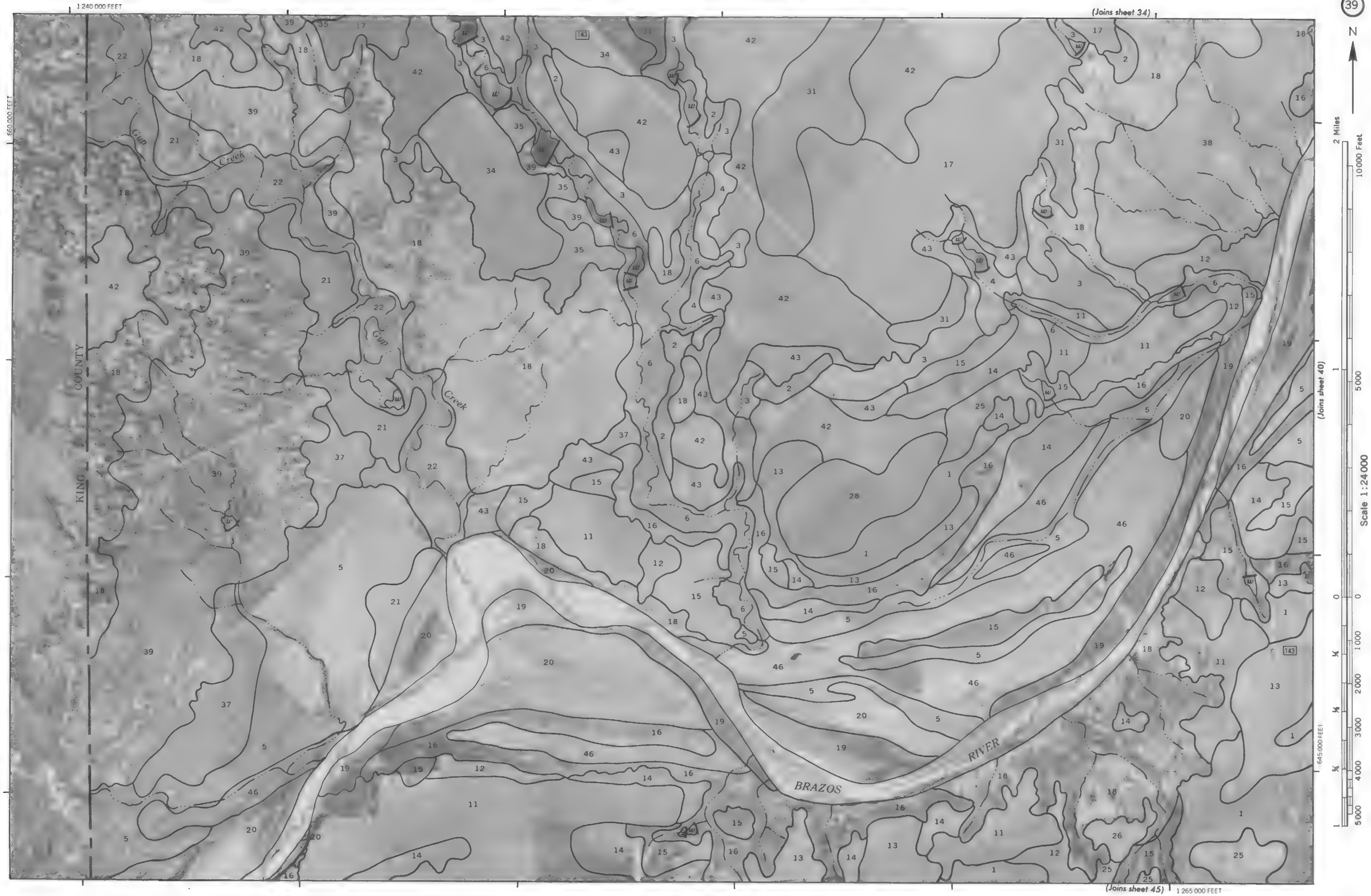
KNOX COUNTY, TEXAS NO. 36

KNOX COUNTY, TEXAS NO. 37

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

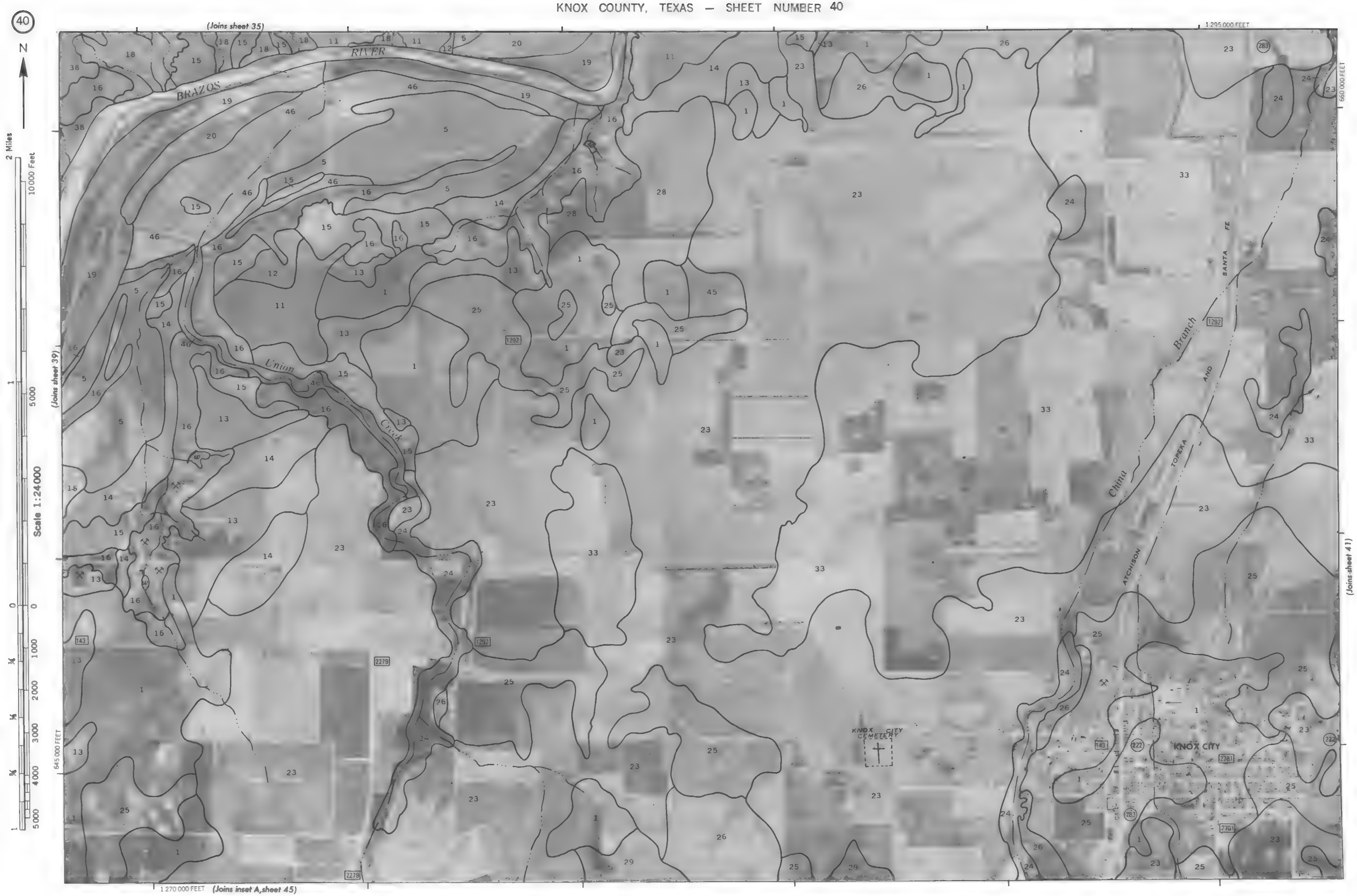


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



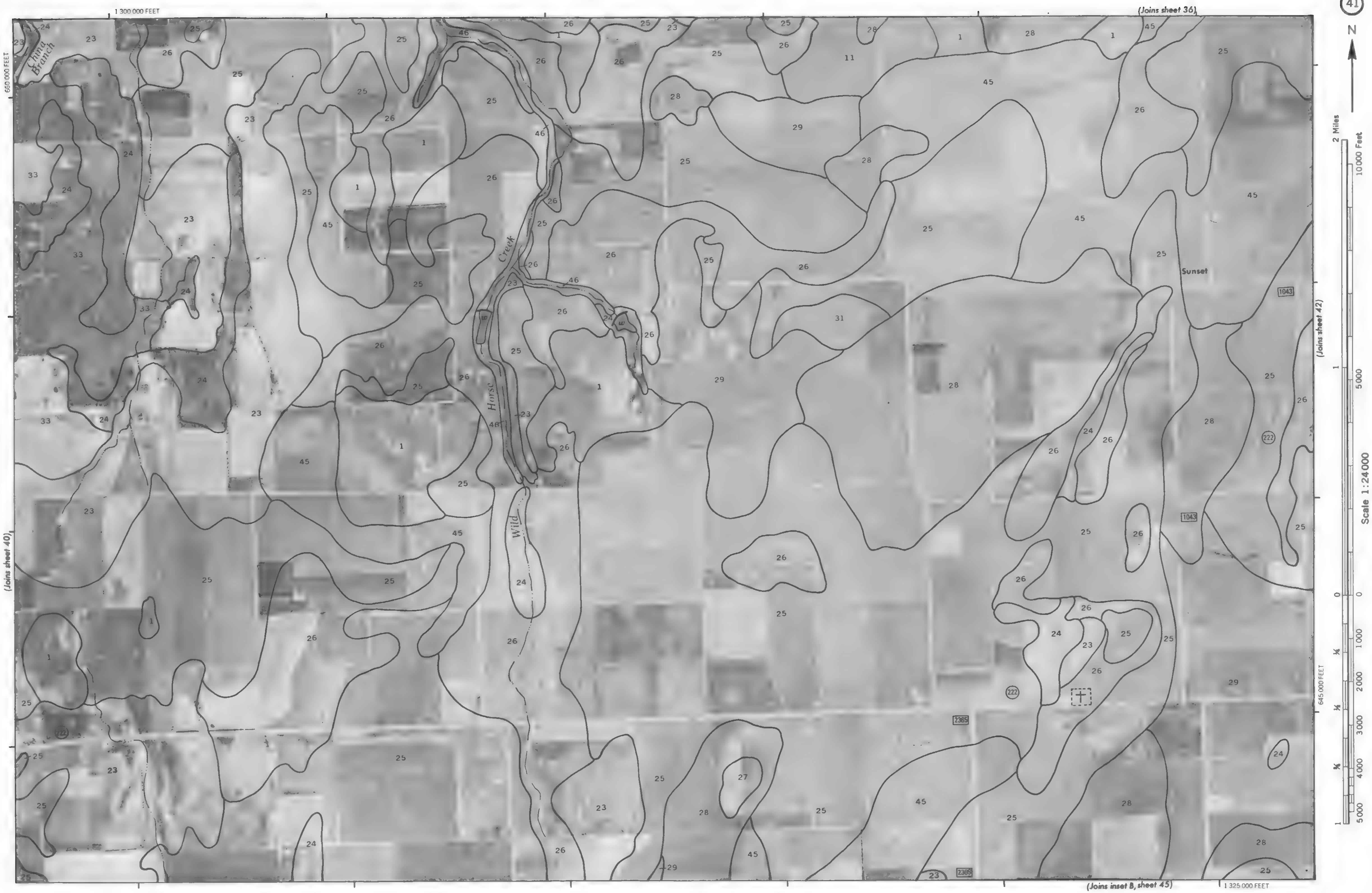
KNOX COUNTY, TEXAS NO. 39

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

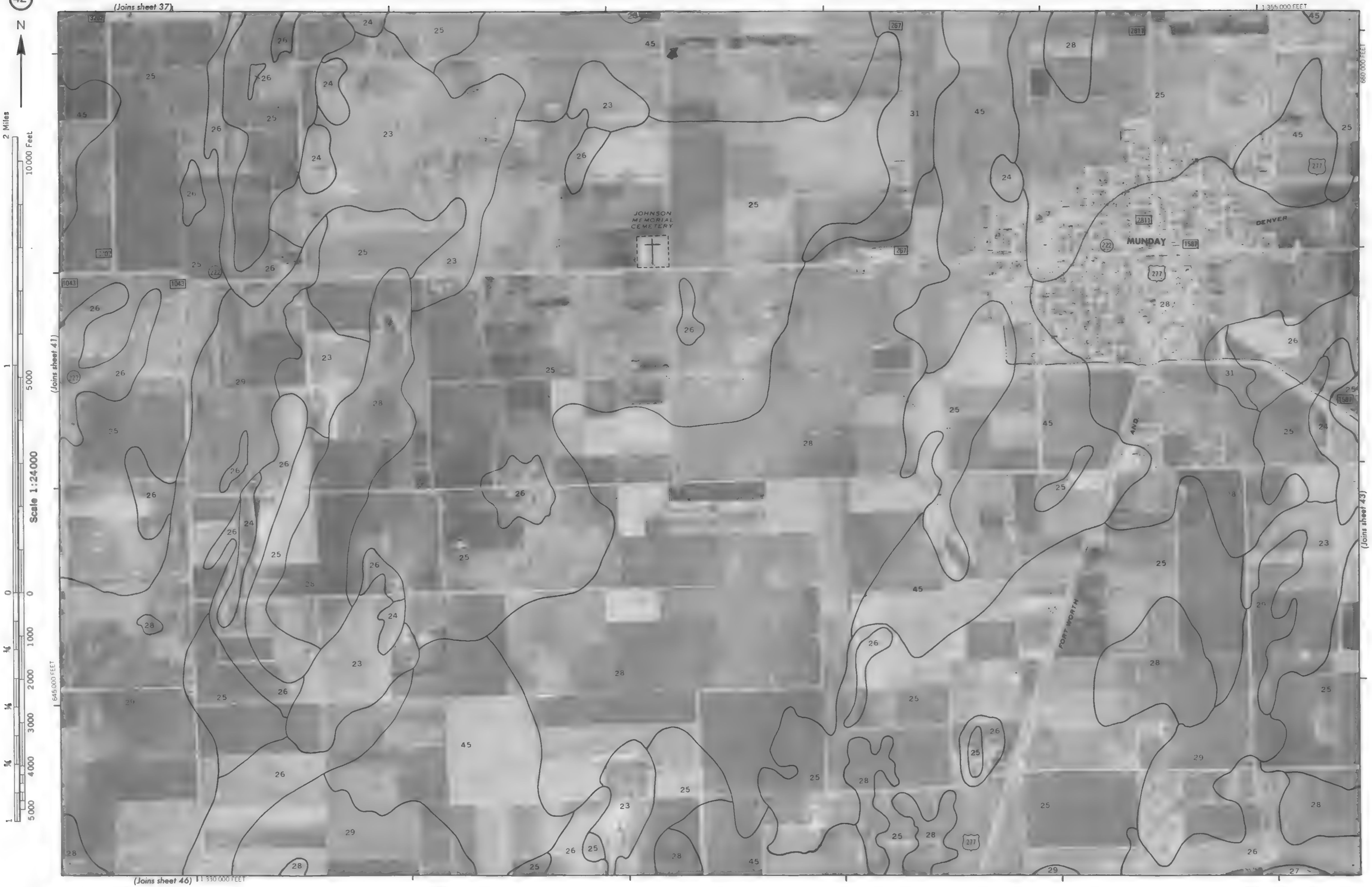
KNOX COUNTY, TEXAS NO. 40



KNOX COUNTY, TEXAS NO. 41

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS — SHEET NUMBER 42

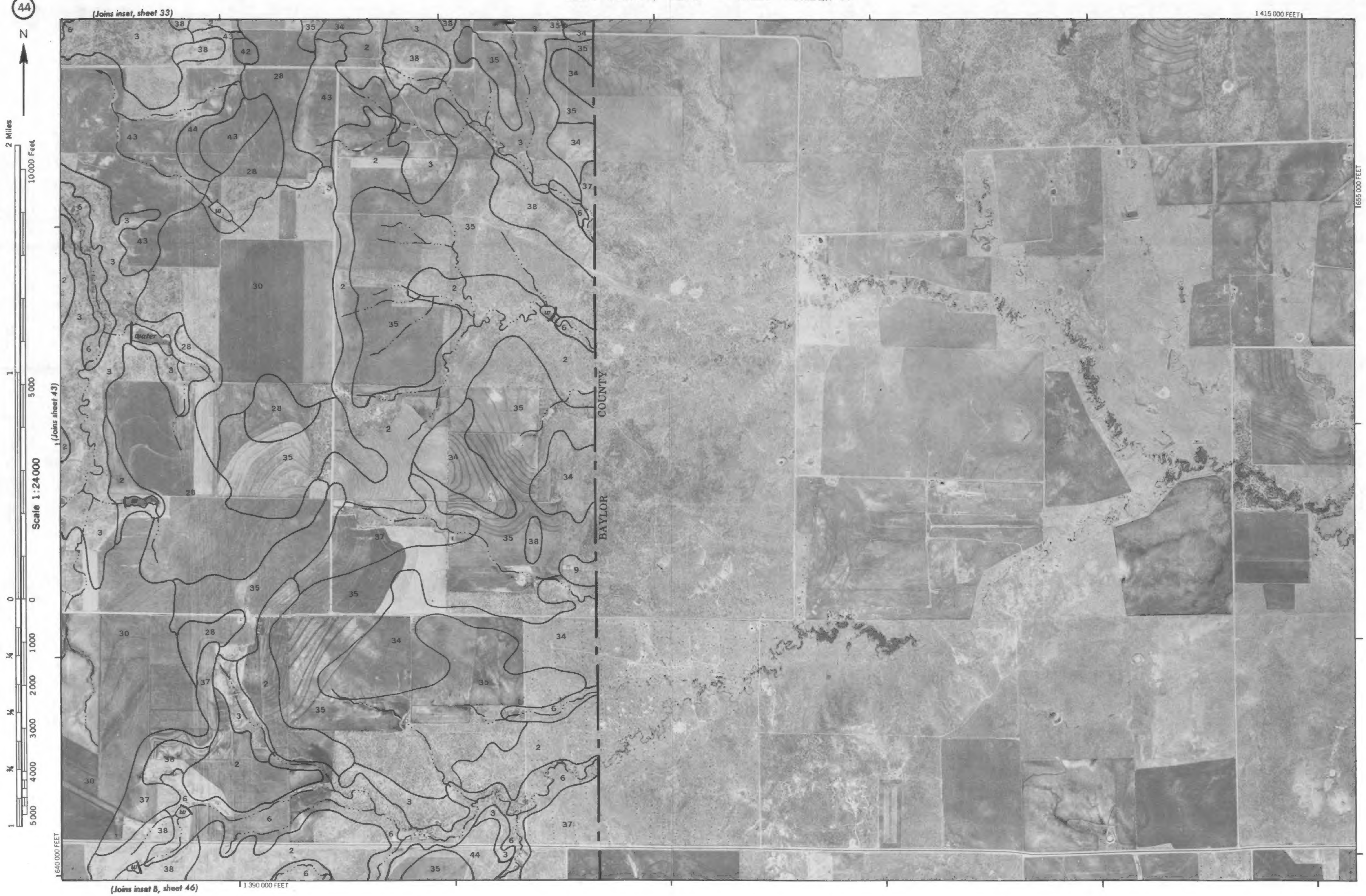


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS — SHEET NUMBER 43

KNOX COUNTY, TEXAS NO. 43

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS NO. 44

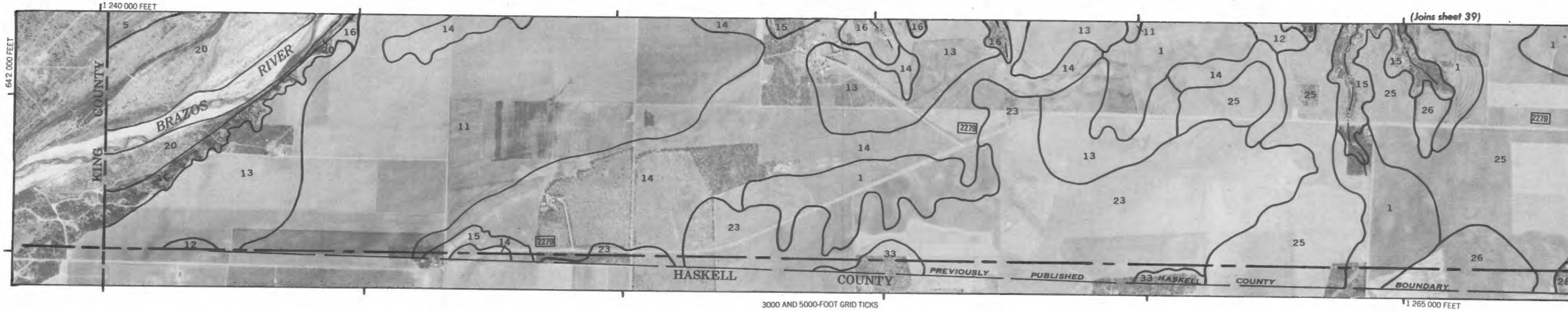
KNOX COUNTY, TEXAS — SHEET NUMBER 45

45

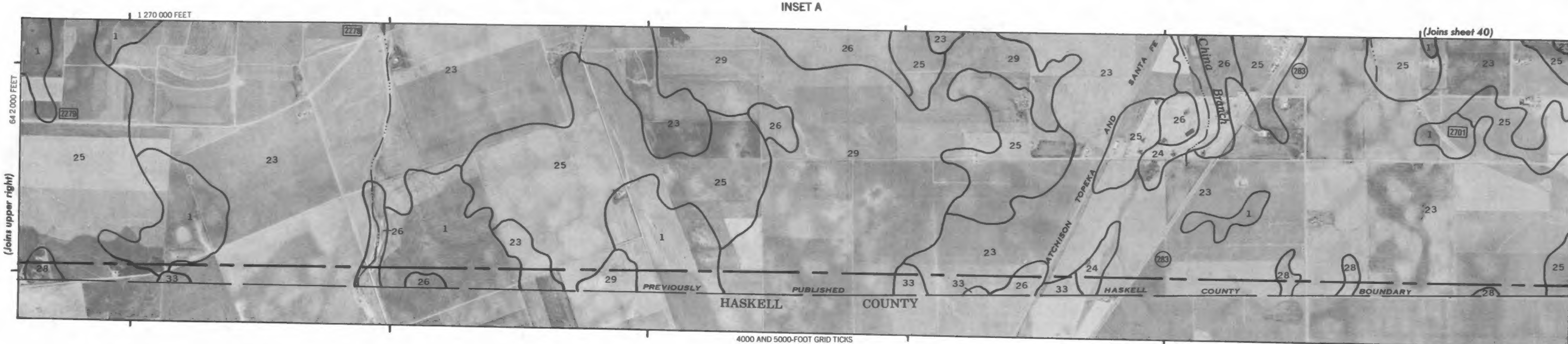
N

KNOX COUNTY, TEXAS NO. 45

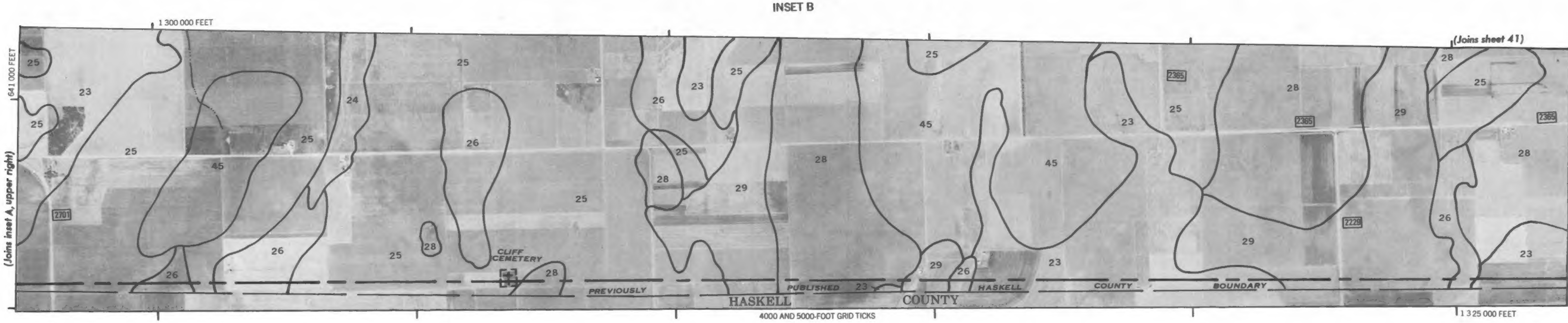
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



INSET A



INSET B



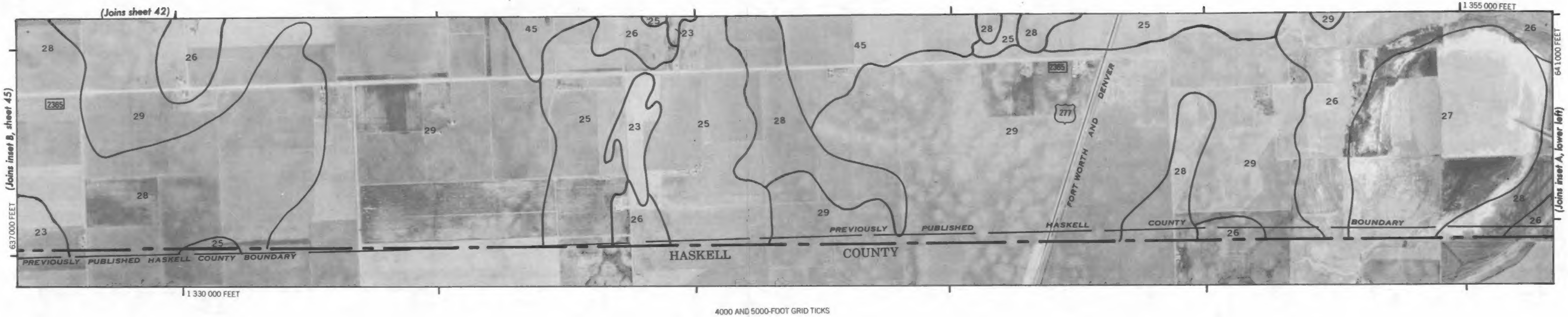
Scale 1:24000

2 Miles — 1 — 0

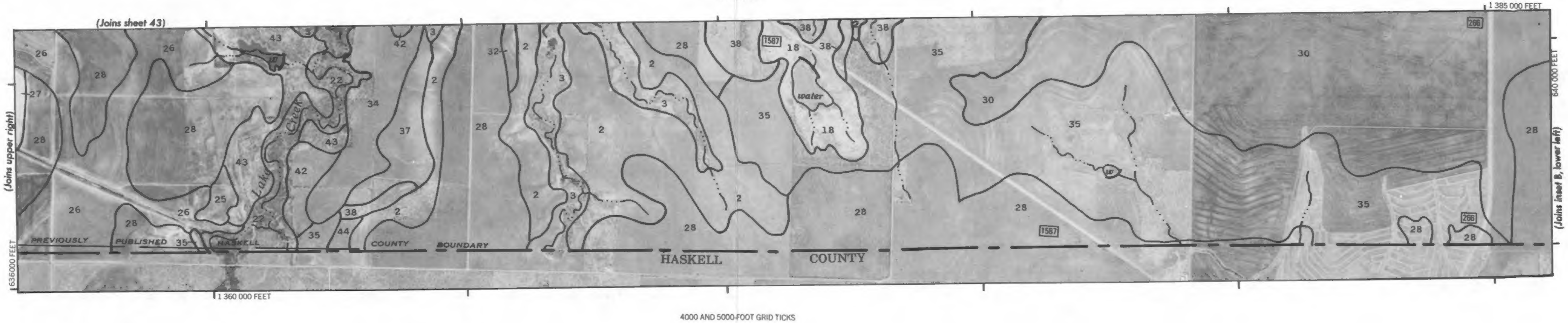
10000 Feet — 5000 — 0 — 1000 — 2000 — 3000 — 4000 — 5000

KNOX COUNTY, TEXAS — SHEET NUMBER 46

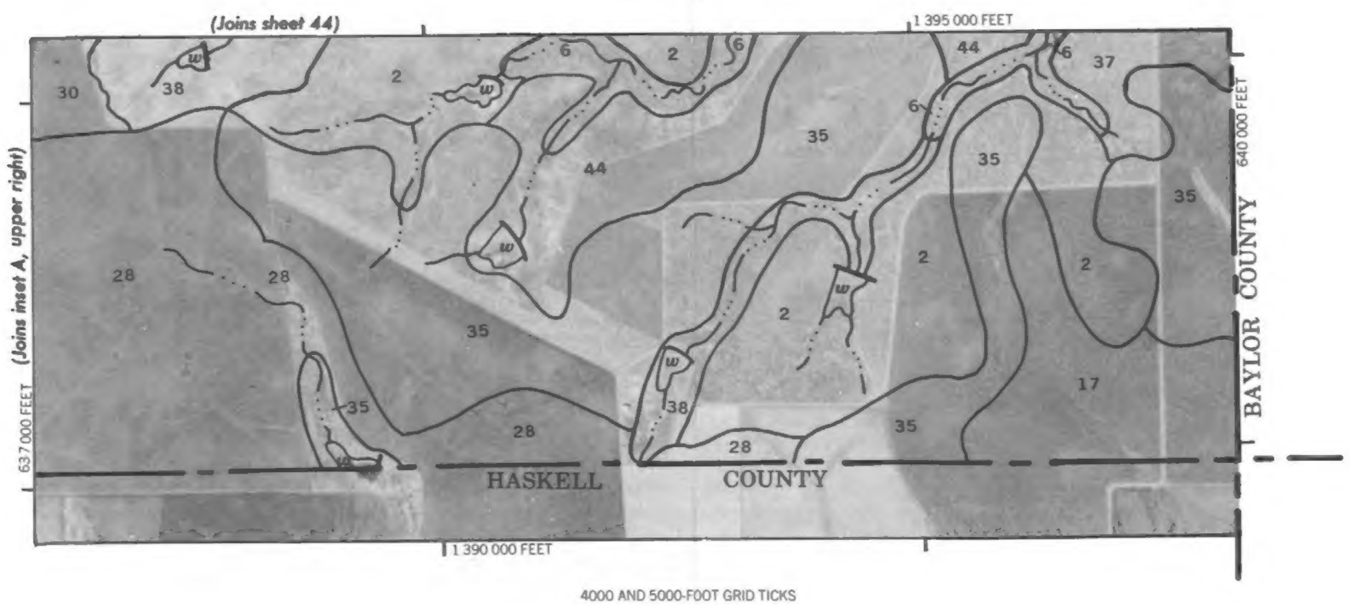
46



INSET A



INSET B



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KNOX COUNTY, TEXAS NO. 46